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Annual Report

May 1, 1983 - April 30, 1984

Illinois State Geological Survey

Illinois Department of Energy and Natural Resources
STATE GEOLOGICAL SURVEY DIVISION

ANNUAL REPORT

to the
BOARD OF NATURAL RESOURCES
AND CONSERVATION

May 1, 1983 to April 30, 1984

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1983 HIGHLIGHTS

COAL

- Efforts increased in research to remove sulfur from coal. Our goals: to make Illinois coal more competitive in the market place and to help solve the acid rain problem. After its start-up in 1983, the Center for Research on Sulfur in Coal (CRSC) is actively engaged in projects dealing with sulfur problems. Six institutions are now involved in collaborative research within the Center: the State Geological Survey, the University of Illinois at Urbana-Champaign, Southern Illinois University at Carbondale, Northwestern University, the University of Illinois-Chicago, and the Argonne National Laboratory.

- At the Survey, stable standard samples of coal collected from four mines have been crushed, screened, homogenized, and stored in steel drums under nitrogen atmosphere to prevent oxidation. These samples are supplied to contractors funded by the Illinois Coal Research Board and to other organizations participating in the coal-sample program. Standard coal samples are critical to obtaining consistent and reliable results in the CRSC projects.

- The potential for producing low-sulfur char (less than 1 percent sulfur) by gas phase treatment alone, without subsequent chemical treatment, has been demonstrated by continuous-feed tests in charring ovens employing counter-flow removal of volatile matter and small-scale tests involving controlled, oxidative desulfurization and temperature cycling. Our analysis suggests a fluidized bed reactor should be more suitable for scale-up to a commercial size than the charring methods used to date.

- The Survey is using radioactive tracers and sulfur isotopes to fingerprint sources of sulfur in coal. We have found that at charring temperatures below 500°C, pyritic sulfur removal becomes more significant. Identifying the forms of sulfur in coal during processing at elevated temperatures should help us to identify the best means of their removal--heating, oxidation or other chemical treatment, or mechanical beneficiation. X-ray diffraction is proving useful for determining the various complex mineral forms of sulfur present at elevated temperatures and after various chemical treatments.

- We have demonstrated that carbon monoxide converts pyrite in coal to pyrrhotite at temperatures as low as 250°C with the formation of carbonyl sulfide. The reaction of carbon monoxide with pyrite is 10 times faster than that of hydrogen with pyrite. Main products of this process include a low-sulfur solid fuel with carbonyl sulfide, a valuable industrial chemical.

The results of research on sulfur removal are promising. But we still have a considerable distance to go to develop commercial processes.

- A new project, supported by the Coal Research Board, has been initiated to investigate the nature of chlorine and sodium in coal and to develop techniques for reducing the amount of chlorine and sodium in coal before combustion. These elements corrode boilers and scrubbers.

- Methods of handling and storing coal have been investigated to reduce the risk of spontaneous combustion. Tests show that riffling wet and dry coals together for storage is better than layering coals, as long as the amount of dry to wet coal does not exceed 4:1.

- In coal-related efforts, we assisted in the development of four reference volumes for an "Illinois Basin Coal Planning Assistance" project. The volumes can be used by the coal industry, communities, and county and state agencies for planning projects, making decisions, establishing good relations between communities and coal companies, and developing land as well as coal resources. These reference works are also available to citizens who simply want to know more about coal.

- Support for our research on the mechanics and strength of materials is increasing. The Illinois Department of Mines and Minerals is submitting coal mine designs to the Survey for analysis of the stability of coal pillars and underclay floor. We are using computer programs to analyze potential subsidence as a result of pillar or floor subsidence. Reported rock strengths are compared with the ISGS rock-strength data base.

- A project creating mined-out area maps on a county-by-county basis was completed. Also, an "Illinois Coal Mines Map and Directory Set" was issued containing mined-out maps and directories for 73 counties.

OIL AND GAS

- Petroleum exploration and production in Illinois continued to bear up well under the impact of the currently depressed price of crude oil. Two factors are largely responsible: (1) the lure of a successful new oil play along the flanks of the Basin, and (2) the shallow average drilling depths (± 2,600 feet) in the Basin, compared to deeper drilling (up to 15,000 feet) elsewhere.

- Illinois Basin projects: work began on a network of eight north-south and six east-west cross sections, part of a basin analysis and regional framework study. Also, cores taken along a northwest-southeast cross section showed the maturity of organic matter increasing from the shallow (northwest) to the deep (southeast) parts of the basin. To identify where source rocks are sufficiently mature to have generated hydrocarbons as well as to identify potential hydrocarbon source beds, another significant project supported by nine major oil companies is continuing.

- Use of the Geological Records room reached an all-time high in 1983-84 due to the high level of oil activity in the state. Copying records, introduced in 1980, reached a feverish level in March, resulting in chaos, disrupting the orderly filing and maintenance of this data base. Steps had to be taken to protect the Survey's data base from abuse and misuse of the records by some industry representatives. At the end of this reporting period, a moratorium had been declared on the copying of well records, while steps were taken to add people, equipment, and a new system to better serve industry needs yet preserve and protect this vital data base.

INDUSTRIAL MINERALS

- We advised a heavy machinery company setting up a program for testing rippability of limestone rocks. We determined the strength and sonic velocities of about 170 samples from 12 limestone quarries and helped the company devise reliable field tests to size the equipment needed for quarrying operations. This led to a $5,000 grant to the Survey in appreciation for the aid given.

- In work funded by the Illinois Department of Transportation, we investigated the freeze-thaw properties of gravel aggregates used in Illinois highways. Chert was found to be the material mainly associated with the expansion of test beams. If aggregate producers know which rock types cause problems, they can develop processes to reduce the deleterious materials in their products or introduce selective mining, avoiding concentrations of undesirable rock types.

ENVIRONMENTAL GEOLOGY

- During the year, a new group was established to emphasize the Survey's role in addressing environmental issues facing the citizens of Illinois: the Environmental Geology program focuses on natural and man-made hazards such as landslides, mine subsidence, and earthquakes. Other projects concentrate on protection of the state's groundwater supplies, management of wastes, and geologic planning for land use--all directly affecting the quality of life.

- An inventory map of landslides was compiled this past year; it shows the location of all known landslides and slumps in the state. A poster display showing the results of this study has been exhibited within the state and at the GSA meeting in Indianapolis last fall. Both the exhibit and an accompanying report summarize types of landslides and tabulate landslide damage and repair costs.

- A computer-assisted directory of claims has been established with funds from the Illinois Mine Subsidence Insurance Fund. Information in the directory, including locations of damaged structures and their causes will aid insurance companies in reviewing nearby and possibly related claims. The directory will speed the Survey's responses to requests for subsidence information. More than 1,200 insurance claims have been filed for mine subsidence since the insurance program began in 1977. Of the damage reported in the claims, 80 to 90 percent had causes other than mine subsidence.

- Our efforts to assist communities and industries in locating, developing, and protecting groundwater supplies are conducted in cooperation with the State Water Survey. Studies are underway to evaluate groundwater resources in Kane County in northern Illinois, other areas in northeastern Illinois, parts of Perry, Jackson, and Randolph Counties in southwestern Illinois, and the Mississippi River Valley in west-central Illinois. High concentrations of radium and barium were found occurring naturally in groundwater from the Cambrian and Ordovician bedrock over a large part of Kane County. This led to a concern for water quality in the area. The county provided funds to look for additional water resources in glacial drift and shallow bedrock.

- The ISGS, the State Museum, and the Department of Energy responded to the first Lands Unsuitable for Mining petition filed by a citizens group. Detailed geologic inventory maps, tables, and cross sections were prepared for the Rice Lake Conservation Area. The Prime 750 computer is being readied as a tool for use in this and other related projects. The computer is specially adapted for automating and presenting regional geologic information on a geographical base. The resulting system is called the Geographic Information System (GIS).

- At the request of the Fermi National Accelerator Laboratory near Batavia, Illinois, the Survey is providing the geologic information for evaluating the feasibility of locating a new 20-trillion electron volt (TeV) super conducting, super collider ring (SSC) near the existing 1.2-mile diameter 1-TeV ring. The new ring will be 20 to 30 miles in diameter. Several states are competing for the $2 to $3 million project with worldwide significance for high-energy physics. The Survey is constructing cross sections and maps that will be used both in engineering the design and in selecting the best corridor for the ring. Currently, a tunnel in bedrock about 300 feet deep is planned. The ISGS, the other scientific surveys, and the State Museum are participating in the environmental screening--to avoid any area with a "fatal flaw."

- For its environmental efforts on Illinois' lakes and rivers, the Survey designed a program to provide government agencies as well as the public with information necessary to manage the Illinois Beach State Park shoreline. Survey geologists determined this area was in danger of destruction within 1 year, documenting their conclusions with data on shoreline recession rates and evaluating the risks. The Survey's findings caused a reversal in federal policy that previously excluded funding for Illinois shore erosion problems. Congress authorized a general shore protection feasibility study of the state-owned portion of the shore.

WASTE MANAGEMENT

- The ISGS also joined the other two surveys, the State Museum, and DENR in proposing a new legislative initiative on hazardous waste. The governor supports the proposed Hazardous Waste Research and Information Center.

- One of the most significant maps ever produced for Illinois was completed this past year. It rates areas of the state for the contamination potential from waste-disposal facilities and practices. Areas most sensitive to contamination are underlain by fractured and permeable bedrock or sand and gravel. Least sensitive areas are underlain by thick glacial till or dense bedrock.

- Work continues at the Wilsonville hazardous-waste site to determine the reasons for contaminants leaking at the site. Sealing efficiencies of natural landfill liners and covers are under investigation. We are also doing research to determine soil sorption capacities for various toxic organic compounds in solvent/waste mixtures.

- The Illinois Department of Nuclear Safety called on the Survey for counsel regarding the geology, geochemistry, and hydrogeology of the Sheffield disposal site where low-level, radioactive, tritium plumes had been detected moving from the site. This past summer, the Survey completed the installation of trench covers newly designed to minimize surface-water contact with the wastes, thus to reduce or inhibit radionuclide migration. The Survey will monitor this site for 2 years to establish the effectiveness of the covers.

BASIC RESEARCH

- On March 1, 1984, the Inter-Survey Geotechnical Laboratory was formed by combining staff and equipment of both the Water Survey Sediment Laboratory and the Geological Survey Particle-Size Analysis Laboratory. The new facility, located at the Annex on south campus, is administered through the State Geological Survey under the guidance of a three-member advisory committee made up of one representative from each scientific survey.

- Geological mapping has been further emphasized. Three 7.5-minute quadrangle maps were recently completed in the Shawneetown fault area of southeastern Illinois. Not only do these maps show the distribution of outcropping coal and the status of strip-mining operations, but they also provide ideas for future strip mining, for directing the search for additional fluorspar deposits, and for stimulating additional oil and gas exploration. Similarly, detailed mapping of the Creal Springs quadrangle has led to a better understanding of structures and coal resources in that area.

- Quaternary stack-unit maps for land-use planning have been constructed for Madison County and initiated for other areas. These maps may be used for locating aquifers, screening sites for landfills and septic systems, locating resources such as sand and gravel, evaluating construction sites, and indicating areas susceptible to flooding.

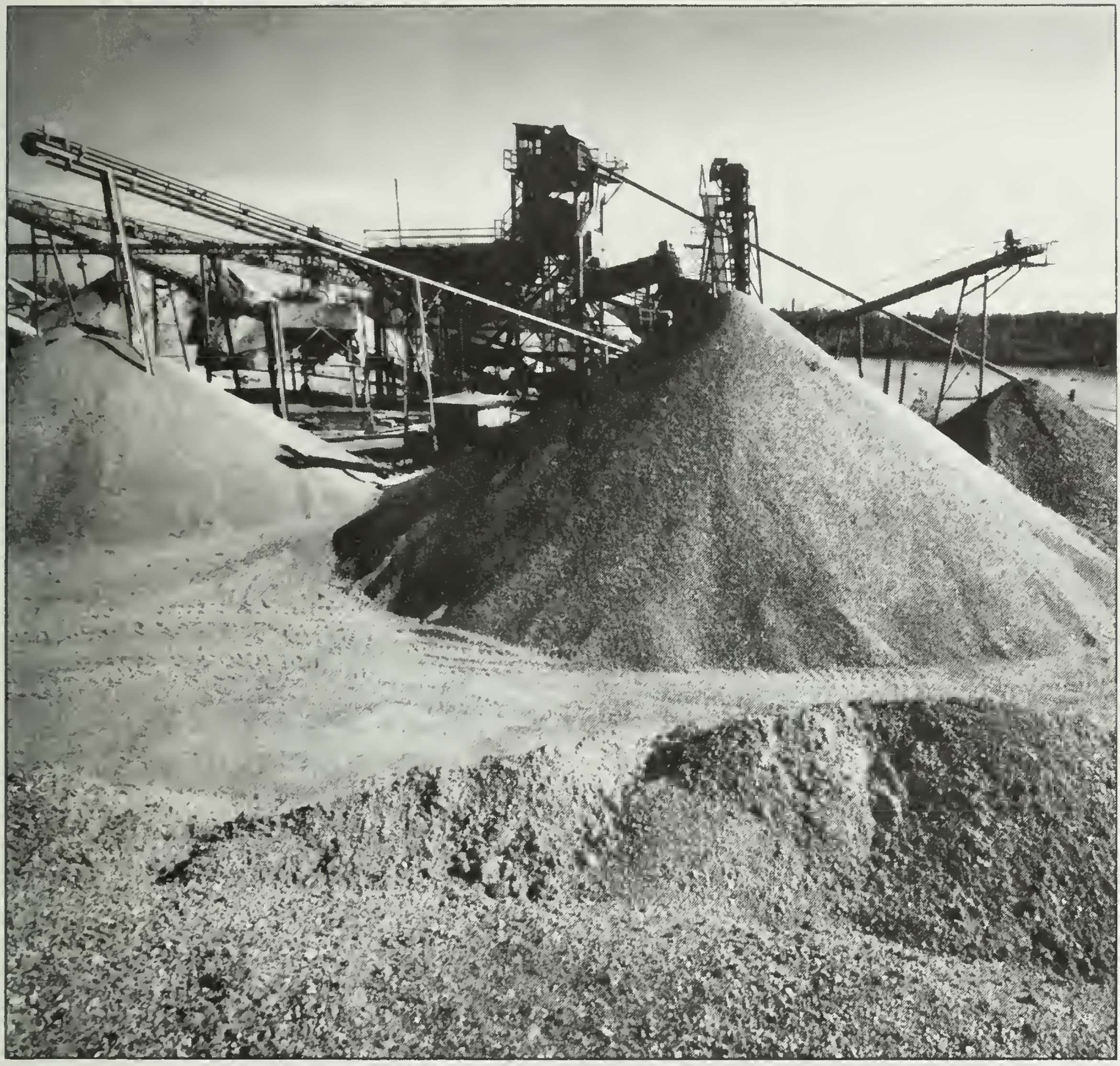
- In our stratigraphic studies, we are continuing to investigate the vertical succession and correlation of rock units both in Quaternary and Paleozoic sediments. These studies provide the basic geologic framework for most of our other projects.

- We are continuing to improve our knowledge of subsurface geology through the acquisition, preservation, and study of borehole samples, cores, geophysical records, fossil samples, and drillers' logs. Subsurface mapping is receiving new emphasis.

- Structural geology is solely supported by outside funding. Little work is being done on structural styles regionally within the state. Also, efforts to undertake deep structural mapping are hampered by the total absence of seismic profiles. Similarly, no work on seismic stratigraphy is possible without this vital data base. A new initiative to evaluate the deep basin petroleum potential failed in the current series of negotiations with the Bureau of the Budget. We are working on new approaches to acquire these data.

- Efforts in paleontology and palynology remain at a healthy level. Our palynologist continues to provide useful information on Pennsylvanian strata--correlating coals, interpreting environments of deposition, and helping to identify controls on coal thickness and coal quality.

MINERAL RESOURCES PROGRAM



Processing plant: Springfield Sand and Gravel Company.

MINERAL RESOURCES PROGRAM

ILLINOIS MINERAL INDUSTRY IN 1982 AND 1983

Figures for the value of minerals produced in Illinois are final for 1982. At this time, the 1983 figures remain estimates.

In 1982, the value of minerals increased 12.5 percent over the previous year to about $2,936 million (Fig. 1). A mine workers' strike in 1981 resulted in lower than expected coal production in that year. Coal accounted for about 60 percent of the total value of minerals, followed by oil at about 30 percent, stone at 6 percent, and sand and gravel at 3.6 percent. Unit price of coal increased by 6.8 percent to $28.84 per ton. Crude oil declined by 6.8 percent to $31.70 per barrel as compared with 1981. Natural gas production continued to decline in 1982; it was about 10 percent lower than in 1981, although its unit value increased by 6 percent to about $2.62 per Mcf (Table 1). Construction activity remain depressed in 1982, resulting in further decline in the production of stone and sand and gravel. Stone production and value were 2.8 percent and 10.2 percent lower, respectively. Sand and gravel production was down 10.5 percent and value was lowered by 12.0 percent. Unit price of stone declined by 7.6 percent, while that of sand and gravel fell by 1.6 percent.

For 1983, preliminary figures (Table 1) indicate that the total value of mineral production may have declined 5 to 6 percent from 1982, primarily due to a drop in coal production of about 2 million tons and a reduction in oil price of approximately $2.50 per barrel. On the positive side, production of stone and sand and gravel are estimated to have increased in 1983 due to increased construction activity. Unit price of stone has increased, while that of sand and gravel has declined somewhat.

Several important measures related to the minerals industry have been passed by the General Assembly during 1983. Two concern electric utilities: 1) coal transportation costs can no longer be automatically passed on to the consumers as part of the fuel price, and 2) the cost of pollution control shall be considered in rate making if Illinois coal is used as fuel. Both laws are expected to reduce competitive disadvantages of Illinois coal versus low-sulfur western coals. Another bill provides corporations with a tax credit equal to 20 percent of the amount spent on research and development approved by the Illinois Coal Research Board. The increase in state sales tax from 5 to 6 percent and the addition of 3.5 cents per gallon in state excise tax as well as 5.0 cents per gallon in federal taxes are expected to encourage highway repair and construction activity, thus stimulating stone and sand and gravel production.

TABLE 1. Mineral production data for 1982 and 1983

		1982		1983		Percentage of change from 1982 to 1983	
Commodity	Unit	Quantity	Value (thousand $)	Quantity	Value (thousand $)	Quantity	Value
MINERAL MATERIALS MINED							
Fuels							
Coal	thousand tons	61,428	$1,771,584	59,329	$1,601,875[a]	- 3.4	- 9.6
Crude oil	thousand bbl	27,710	878,120	29,200	846,800[a]	+ 5.4	- 3.6
Natural gas	thousand Mcf	1,162	3,043	1,030	2,926[a]	-11.4	- 3.8
Industrial and construction materials							
Stone	thousand tons	42,900	148,300	44,502	172,067	+ 3.7	+16.0
Sand and gravel	thousand tons	25,546	104,814	26,000	103,000	+ 1.8	- 1.7
Clays[b]	thousand tons	455	2,305	445	2,178	- 2.2	- 5.5
Fluorspar	thousand tons	W	W	W	W	-19.9	-20.7
Tripoli	thousand tons	W	W	W	W	+71.4	+70.6
Metals							
Lead	tons	W	W	W	W	-37.2	-46.3
Zinc	tons	W	W	W	W	-29.1	-22.5
Silver	troy ounce	W	W	W	W		-75.0
Other							
Peat	thousand tons	47	1,514	W	W		
Gem stones		NA	15	NA	15		
Barite, primary	thousand tons	W	W	W	W		+ 1.3
Values that cannot be disclosed (W)			25,860[c]		28,738		+ 5.0
Total value of mineral materials mined			$2,935,565				

[a] Estimated by ISGS

[b] Excludes fuller's earth; included with Values that cannot be disclosed (W).

[c] To calcuate percent change, add peat to values not disclosed for 1982.

W Withheld to avoid disclosing individual company confidential data.

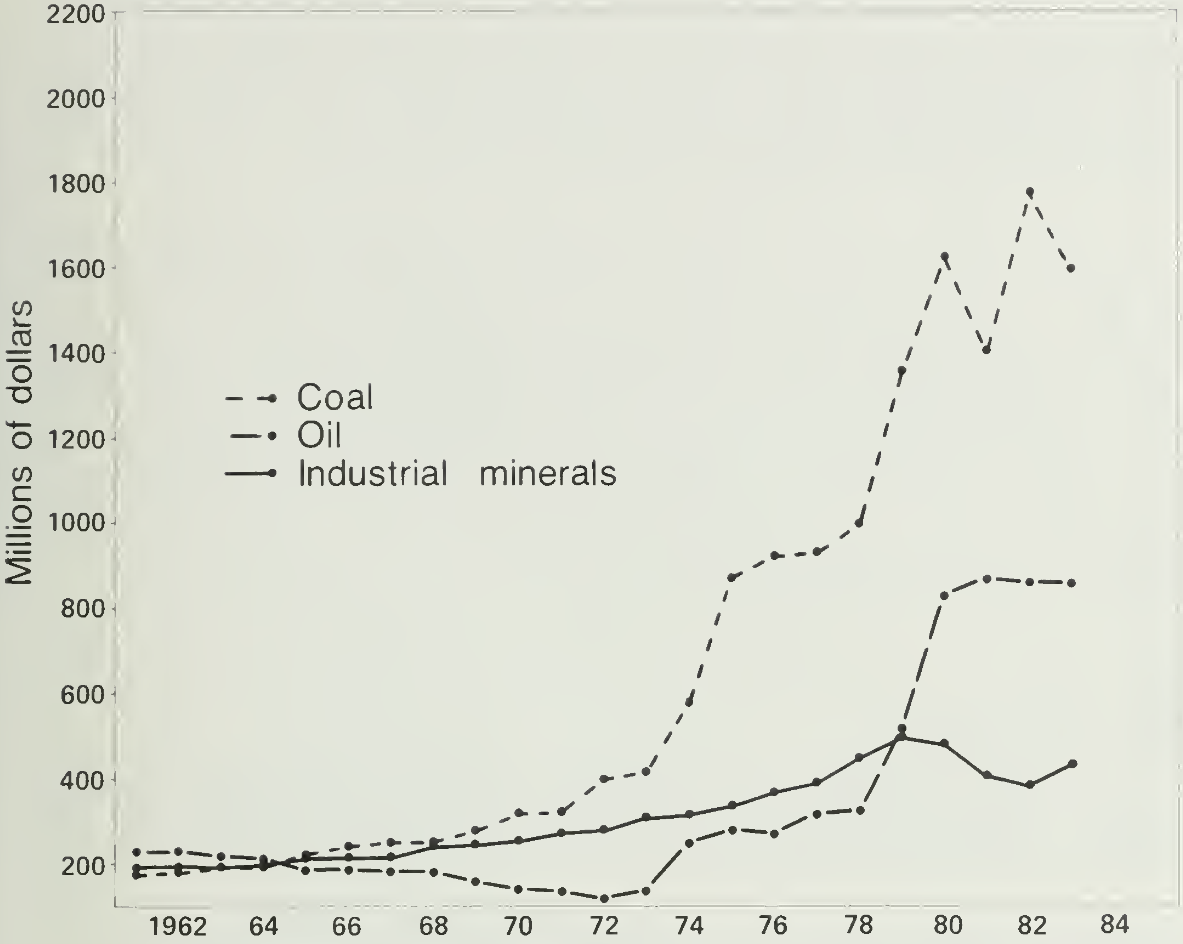


Figure 1. Annual value of Illinois mineral production.

MINERAL RESOURCES RESEARCH AND SERVICE

To support and strengthen the economy of Illinois, the State Geological Survey's mineral resources program includes research and service activities on coal, oil and gas, and industrial minerals--limestone, dolomite, sand and gravel, fluorite, lead, and zinc. Efforts in coal research are concentrated on making Illinois coal more usable and more competitive in the market place. At the same time, the Survey is seeking solutions to the acid rain problem.

The data base for all mineral resources continues to improve. Particular focus is on the quality and quantity of Illinois coal deposits as well as those aspects affecting coal minability. In oil and gas, attention is turning to the hydrocarbon potential of deeper, older rocks in the Illinois Basin and to the possibilities of migrated oil, especially in stratigraphic traps occurring in shallower positions than the areas of hydrocarbon generation. For the industrial minerals program, the Survey is currently concentrating on urban areas, attempting to locate additional mineral aggregate sources close to markets. To expand development of this economic resource, other studies are assessing the feasibility of underground mining.

COAL

ISGS Coal Program

The Geological Survey has designed its coal programs to encourage economic development and wise use of Illinois' extensive bituminous coal resources--which are the largest in the United States.

During the past year, studies have been concerned with the location, quantification, and characterization of coal resources. In addition, the factors governing the deposition and formation of coal were studied, thus enhancing our ability to predict the persistence of known coal seams and the potential for discovering additional deposits. Lithologic, structural, and rock mechanical investigations of coal-bearing strata contribute to the solution of problems encountered during mining as well as those of mine subsidence. Studying the composition of coal provides important data concerning its utilization and pollution potential. Finally, the major problem in the utilization of Illinois coal--sulfur content--is being attacked by research on precombustion methods of sulfur removal.

Many of the Geological Survey's research projects that deal with the sulfur problem are coordinated with the CRSC, (note the individual project descriptions). The Center, which is located at the Geological Survey, is supported by the Survey, the University of Illinois at Urbana-Champaign, Southern Illinois University at Carbondale, Northwestern University, the University of Illinois-Chicago, and the Argonne National Laboratory.

Coal Mining Industry Activities (Damberger, Bhagwat, Wells, and Morgan). No new mines were announced; several mines halted production either temporarily or permanently. Coal exploration is in a holding pattern, but development drilling around existing mines seems to have picked up, judging from the number of plugging affidavits filed. The increased economic activity during the past year has not yet substantially increased the demand for coal. Hopes for expanding exports are low in view of the problems with the quality of Illinois coal, the high price of U.S. coal in overseas markets, and high transportation costs (e.g., rail deregulation).

Coal Resources and Geology

Coal Exploration Records (Morgan). The data base--a vital part of Survey research and service--increased during this report period. Drill core data were acquired mainly from drillers' logs, geophysical logs, and company geologists' logs. Approximately 400 drillers' logs, 160 geophysical logs, and 40 company core descriptions were recorded from 4 coal companies and 9 counties.

Coal Resources in Illinois (Treworgy and Bargh). The U.S. Bureau of Land Management has provided additional funds ($15,000) to publish (1) a report discussing methodology used in preparing a series of mylar overlays of coal resource data for sixty-seven 7.5-minute topographic quadrangles that contain federally owned land (mylars were compiled last fiscal year with BLM funding); (2) a series of statewide, 4-color coal resource maps that show general coal thickness, depth, and tonnage for 29 mapped coal seams in Illinois. The coal resource quadrangle maps will be used by BLM in asessing the coal resources on federally owned land and in evaluating the need for continued ownership of these properties.

For the first time the statewide resource maps will show the known coal resources, both deep and surface minable, for all mapped coals in Illinois in terms of thickness, depth, and tonnage by area. The maps will be valuable to industry, government, and land and mineral owners for resource assessment and management.

Coal Resources of La Salle, Livingston, and Grundy Counties (Jacobson). This report will substantially update the coal resources of the three counties covered. Editing of a manuscript has been completed and drafting of the numerous figures and plates has begun.

Stratigraphic Correlations of the Seelyville, Dekoven, and Davis Coal Members of the Spoon Formation, Illinois (equivalent to Staunton Formation of Indiana and Carbondale Formation of Western Kentucky) (Jacobson). Work was completed on cross sections of subsurface logs demonstrating clearly that the Dekoven and Davis Coals are splits of the Seelyville Coal. A draft of a manuscript was also prepared. This study is significant because it helps us understand the relationships of three important economic coal seams in the Illinois Basin Coal Field.

Fulton County Structure (Trask). This is the first map in a planned series of county maps on the structure and resources of Illinois coals. Such county maps have been requested many times by industry and will also be beneficial to landowners who have questions concerning coal resources. The Fulton County map is on the margin of an area being explored for oil and gas. It is anticipated that the detailed structural analysis will stimulate drilling in new, unexplored areas.

Illinois Basin Coal Planning Assistance Project (Treworgy, Nelson, Berggren, Damberger, and Bhagwat). The Illinois Basin Coal Planning Assistance project, funded by the U.S. Geological Survey (USGS), was a cooperative effort among the USGS, the ISGS, the Indiana Geological Survey, the Kentucky Geological Survey, and the Environmental Systems Application Center at Indiana University's School of Public and Environmental Affairs (SPEA). The goal of the project was to prepare a planning reference system to aid planners, local government officials, industry, and other interested parties in planning for, analyzing, and mitigating the environmental and socioeconomic impacts related to coal development.

The reference system includes four separate but complementary volumes written in simple, nontechnical language. Volume 1, Coal Resources Fact Book, is the foundation of the reference system. It surveys mining methods, coal markets and transportation, and geologic factors affecting coal in the Illinois Basin. Chapters by the geological surveys of Illinois, Indiana, and Kentucky provide detailed information on coal resources, current mines, and coal quantity. The other volumes were written by staff members of SPEA of Indiana University. Volume 2, Natural Resources Guide Book, focuses on soils, groudwater, surface water, air, wildlife, fish, noise, scenic-visual analysis, and land use: drawings, photography, and map overlays illustrate important natural processes related to coal. Also, typical mining impacts, effective mitigation, and reclamation strategies are detailed. Volume 3, Socio-Economic Resources Guide Book, assembles information on the population and economy of the Illinois Basin states and introduces simple methods of predicting the socio-economic impacts of coal development on communities of all sizes. Volume 4, Information Source Book, discusses planning, technical assistance, library and bibliographic resources, maps, aerial photographs, satellite imagery, and published and unpublished reference materials.

The four-volume reference system can be used by the coal industry in project planning, by local decision makers in their relations with the community and coal companies, by citizen groups who want to know more about coal, and by community, county, and state planners responsible for short- and long-term development.

Coal Mining Geology

Review of Coal Mine Plans for Subsidence Potential (Bauer). The Illinois Department of Mines and Minerals (DMM) has begun to submit coal mine designs to the Survey for analysis of the stability of coal pillars and the underclay (floor). Public Law 95-87, the "Surface Mining Control and Reclamation Act of 1977" requires that mining plans be analyzed for potential subsidence as a result of pillar or floor failure. Eight mine designs were reviewed for DMM. The analysis is aided by using five computer programs that Bauer wrote for this purpose. An important part of the analysis is the comparison of reported rock strengths with the ISGS rock-strength data base.

Strength Testing of Coal Bearing Strata (Fox and Bauer). Two companies provided exploration cores for testing. The collection of base line data on the strength of rocks associated with minable coal seams and the coal itself continued in cooperation with mining companies. Our slake-durability data were a good predictor of in-mine roof stability according to a representative of one of the companies. The slake-durability test simulates the degradation of the rock during multiple wetting and drying cycles. Areas of the mine where our test showed a high degree of slaking experienced the greatest roof control problems.

Prediction of Compressive Strength from Point Load and Moisture Content Indices of Highly Anisotopic, Coal-Bearing Strata of the Illinois Basin (Bauer). Bauer completed his master's thesis under this title; it summarizes 7 years of rock mechanics testing at the ISGS. A good correlation between simple field tests of strength and expensive, time-consuming laboratory tests was demonstrated. This will allow strength testing of freshly collected rocks at the time of core drilling.

Mined-Out Areas of Illinois Coal: Map and Data System (Danner, DuMontelle, Bargh, Chenoweth, Krzyzak, and Kar). The project created a set of mined-out area maps on county bases and a set of county mine directories. In December 1983, the Survey issued the "Illinois Coal Mines: Map and Directory Set," which contains maps and directories for 73 counties in the state. The maps are now available to the public as blue-line prints at a scale of 1:62,500. This project was jointly funded by the Office of Surface Mining and Illinois Abandoned Mine Lands Reclamation Council. These maps are proving useful to planning commissions, engineering firms, coal companies, drilling companies, real estate agencies, and various state and federal agencies.

Study of Surface Lineaments in Coal Mining Areas of Illinois (Danner). A project has been started to investigate how linear features on the earth's surface relate to discontinuities in the underlying bedrock. Surficial lineaments that are often obscured at ground level can sometimes be detected from imagery recorded by remote platforms such as Landsat satellites, Skylab, the Space Shuttle, and aerial photography. In some cases these lineaments are surficial manifestations of underlying fault and fracture zones in the bedrock. Bedrock discontinuities can have an adverse effect on coal mining. If relationships can be established between certain linear features and bedrock discontinuities, mining companies could use lineament maps to predict geologic anomalies in advance of mining.

Composition of Coal

Distribution of Maceral Composition of Illinois Coals (Harvey and Dillon). This work is part of a long-term program on the petrographic characterization of Illinois coals. The results will be useful for evaluating the interrelations between maceral and chemical composition and coal quality at sampling sites--also for predicting coal quality in unexplored areas of the state. Maps of data on channel and drill core samples revealed some potentially useful patterns of maceral composition in the Springfield and the Herrin Coals. A paper is being written for publication in a scientific journal, with Dillon as co-author.

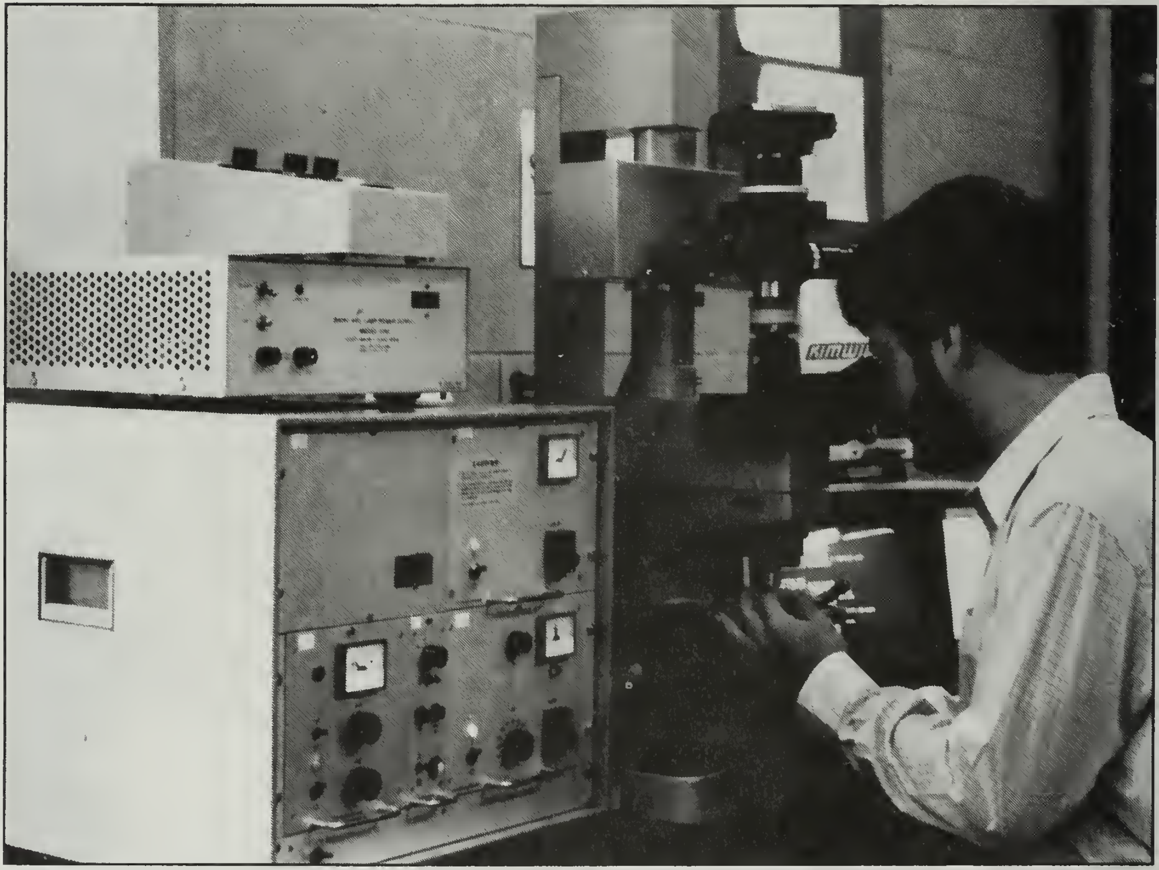


Figure 2. Organic petrography being performed on a Leitz MPV II reflected light microscope. Reflected light techniques allow the petrographer to evaluate coal rank and composition, as well as petroleum source rock (kerogen): Wesley Dillon, Coal Section.

Information System on Chemistry of Illinois Coals (Harvey, Kar, Bargh, in cooperation with Kohlenberger). The objectives are to design and install a computerized data base consisting of the chemistry of Illinois coal samples, identified by sample type, geographic location, seam name, and other characteristics. A user manual will allow the information to be accessed via telephone-computer facilities or by magnetic tape. Coal researchers, public officials and some private companies will be interested in this information.

Recently, the computer procedures and programs were improved in order to enter new chemical data, edit and update our primary files, and otherwise better manage our files. Chemical data on approximately 100 channel, drill core, and other samples were added to our primary data files during the year. These files now contain descriptive information and analytical results on about 8,000 samples of Illinois coals.

Characterization and Removal of Chlorine and Sodium from Illinois Coals (C.-L. Chou, Cahill, and Chaven). Efficient methods must be developed for removing chlorine and sodium from Illinois coal; these elements corrode boilers and scrubbing equipment. With the support of the Illinois Coal Research Board, we have initiated a project (1) to investigate the nature and distribution of chlorine and sodium in Illinois coal, and (2) to develop techniques to reduce chlorine and sodium contents in coal before combustion.

Inorganic Geochemistry of Illinois Basin Coals (C.-L. Chou). Studies of trace elements and mineral matter in coal are important to eliminate potentially detrimental effects on equipment and on the environment during coal utilization. The chemical and mineralogical composition of more than 100 samples of Illinois Basin coal have been examined from an existing data base. High-sulfur coal is significantly enriched in certain trace elements (iron, molybdenum, thallium, boron), in contrast to low-sulfur coal. Either seawater (S, Mo, and B) or a terrigenous source (Fe and Tl) is possible. These elements were apparently deposited in high-sulfur coal under a reducing, sulfur-rich environment. The geochemical processes and controlling factors leading to the observed positive correlation between sulfur and these trace elements will be further investigated.

Composition and Distribution of Mineral Matter in Herrin Coal of the Illinois Basin (C.-L. Chou and Harvey). The mineral composition of the low-temperature ash in 61 channel samples and drill cores of the Herrin Coal was analyzed. Face channel samples of the Herrin Coal contains an average of 15.7 percent of low-temperature ash, including 2.4 percent quartz, 1.4 percent calcite, 2.9 percent pyrite, and 9.0 percent clay minerals. In the Herrin Coal low-pyrite coal samples occur in relatively restricted areas where the coal is overlain by a thick layer of nonmarine Energy Shale. This contrasts with high-sulfur coal areas lying beneath in roof strata of marine origin and suggests that pyrite formed in a sulfur-rich, reducing environment associated with seawater transgression. The nature of roof strata appears to be a useful indicator of the quality of underlying coal.

Compared to the overlying Anna Shale and Energy Shale Members, the Herrin Coal is significantly enriched in kaolinite. This may be attributed both to authigenic kaolinite, formed in the acidic peat swamp, and to that formed epigenetically as cleat filling.

Nuclear Magnetic Resonance Studies of the Organic Structure of Coal and Coal Process Residues (M. Chou). The development of carbon-13 cross polarization (CP) and magic-angle spinning (MAS) nuclear magnetic resonance (NMR) spectroscopy with high-power proton decoupling has allowed investigators to obtain spectra of the organic matter in solid coal. This technique has been adapted to chars produced by the flash pyrolysis of an Illinois (No. 5) coal at progressively increasing temperatures. The resulting spectra have given valuable insight into the changes in the organic composition of coal during carbonization as well as the optimum temperature for efficient conversion of coal into liquids and gases.

Self-Heating Susceptibility of Coal and Coal Blends (R. Frost and Thomas). An old problem of self-heating became intensified when large imports of western subbituminous coal began arriving in Illinois, then either transported on barges or stored in piles for use as steam coal. Although low in sulfur, this coal dries easily and becomes very friable--conditions that lead to self-heating and spontaneous combustion.

A laboratory investigation (partially supported by EPRI funds) was conducted on the self-heating of four Wyoming subbituminous, three Illinois and one West Virginia bituminous coals, and blends of the subbituminous and bituminous coals. The results showed that adsorption of moisture contributes to the self-heating and thereby significantly accelerates the rate of self-heating of dry coals due to oxidation. Subsequent tests with blends showed partially dried coals to be an important source of moisture, which alone or in combination with moisture in the test atmosphere could promote the self-heating of a vacuum-dried coal to the point of ignition. In some tests, however, excess moisture from a partially dried coal suppressed the self-heating of the vacuum-dried coal.

The test results show that, unless multiple layers are used, riffling wet and dry coals together for storage is much better than layering a dry coal on top of a wet coal or vice versa. However, blends produced by riffling wet coal with relatively larger amounts (>4 to 1 by volume) of dry reactive coal are quite susceptible to self-heating and should be avoided unless storage time is quite short.

Coal Analysis

X-ray Diffraction (Hughes and Glass). The Survey, Southern Illinois University, and the University of Illinois are conducting cooperative X-ray diffraction work (partially funded through the CRSC) for mineral characterizations of coal and coal-desulfurization products.

X-ray diffraction (XRD) is being used to determine changes in sulfide mineral composition that parallel inorganic sulfur removal from coal. During heating, carbon monoxide treatment, and oxidation of pyrite and marcasite, minerals form a complex series. Knowledge of this series gained with XRD can be used in the design and optimization of desulfurization methods.

Together with Moessbauer spectroscopy and chemical analyses, XRD is being used to detect changes in mineral composition and to identify synthetic or natural sulfides, sulfates, hydroxides, and oxides that relate to the problem of removing sulfur from Illinois coals. Because coals, chars, and residues are analyzed with no pretreatment, results are rapidly obtained without alteration problems due to sample preparation.

Methods Development (Chaven). The Minerals Engineering Section has added analytical capabilities during the past year: (1) a new method for determination of chlorine in coal, and (2) an IBM-PC controlled data acquisition system for the Erba elemental analyzer. The chlorine analysis method is very accurate and reasonably fast; it is being routinely used in place of the ASTM method both in Champaign and at SIU-Carbondale. The automated acquisition system, which interfaces a computer with the elemental analyzer, electronic balances, pH meter, and other analytical instruments, is about 50 percent completed. It will not only speed up data handling but also minimize errors occasioned by manual transfer.

Coal Analysis Laboratory (Chaven, McMillion, and Kohlenberger). The Coal Laboratory analyzed about 350 samples in the past year, representing a cross section of Survey research projects. The major source of samples was the Fine Coal Cleaning project. For the last several years, the Coal Laboratory has participated in monthly round robins conducted by Standard Laboratories, Inc. of Charleston, West Virginia. Our results have generally been quite satisfactory. We are now cooperating with an investigation of the ASTM method for forms of sulfur in coal (D-2492) to quantify the amount of pyritic sulfur that is not totally removed in the nitric acid extraction. Also, software updating is simplifying the handling of coal composition data and the generation of analytical reports.

Coal Desulfurization and Coal Cleaning

Size and Maceral Association of Sulfide Grains in Illinois Coals and Their Washed Products (Harvey, DeMaris, Lowry, Lincoln, in cooperation with Khan, Buckentin, Camp, and Kohlenberger). This work, funded by the Illinois Coal Research Board through the CRSC, concerns the forms of sulfur in coal and aims, by means of a microscopic study, to consider ways for improvement of grinding and cleaning of coal. The project objectives are to develop a microscopic method to measure the size and association of sulfide grains in coal, to determine these properties in selected samples of feed and washed (float-sink) coals, and to seek correlations with the washing behavior.

A satisfactory microscopic method was developed and applied to three feed coals and their washed products. The pyritic sulfur content of 30 project samples was measured microscopically and chemically. The microscopic results trend with the chemical results, but the former are anomalously high indicating that the sulfide grains in the microscopic specimens examined were not truly representative of the samples tested for chemistry. Evaluations of the large amount of data generated for the project are in progress and a final report is being prepared.

Petrographic and Mineralogic Investigations of the Potential for Cleaning Fine Coal (Harvey, DeMaris, Lowry, in cooperation with Ruch, Kruse, Buckentin, and others). The objectives of a recently initiated project are to determine the microlithotype and mineral analyses of feed coals and their cleaned and refuse products. These tests will aid in evaluating the effectiveness of different laboratory cleaning processes. The project is part of a larger project funded by the Coal Research Board through the CRSC entitled "Limits of the Removal of Sulfur, Chlorine and Trace Elements from Fine Coal."

Low Temperature Charring of Coal (funded in part by CRSC).

Development of Charring Reactors (Stephenson, Rostam-Abadi, and Kruse). Charring of coal to reduce the sulfur content may present an attractive alternative to other desulfurization processes. Early results indicated that coal char produced from Illinois coal under specified conditions loses appreciable amounts of sulfur; the resulting char, still containing significant amounts of sulfur, can be much more readily desulfurized than the feed coal.

More recently, studies of various charring modes have been initiated to develop an economical process by which a low-sulfur char can be produced.

The results from our continuous-feed tests in the ISGS charring ovens employing counter flow removal of volatile matter and those from recent small-scale tests involving controlled, oxidative desulfurization and temperature cycling have demonstrated the potential for producing a relatively low-sulfur char (less than 1 percent) by gas phase treatment along--that is, without subsequent chemical treatment. Our analysis suggests a fluidized bed reactor (FBR) should be more suitable for scale-up to a commercial size than the charring methods used to date. Fluidization converts a bed of solid particles into an expanded, suspended mass that resembles a boiling liquid. The advantages include excellent solid mixing and enhanced heat and mass transfer. Our engineers have completed the design calculations for a bench-scale batch FBR to be fabricated and installed in the second quarter of 1984. A unique feature is the provision for controlled cooling as well as heating to take advantage of the benefits of temperature cycling, which may be a critical factor in the desulfurization process.

Thermogravimetric Studies of Coal (Rostam-Abadi and Kruse). Reaction rates for the pyrolysis of coal are basic engineering requirements for the development of a low-temperature carbonization process. A simplified kinetic expression that describes the overall reaction is being sought for process engineering and modeling calculations.

Thermogravimetry (TG) is being used to obtain the effective kinetics for the devolatilization and desulfurization of several Illinois coals. The temperature at which the rate of devolatilization is highest appears from TG tests to be related to the ratio of forms of sulfur in coal. This may have practical applications because the ratio can be altered by physical cleaning, and a lower devolatilization temperature may be needed to avoid agglomeration. The latter is a particularly serious problem in coal-fluidization processes.

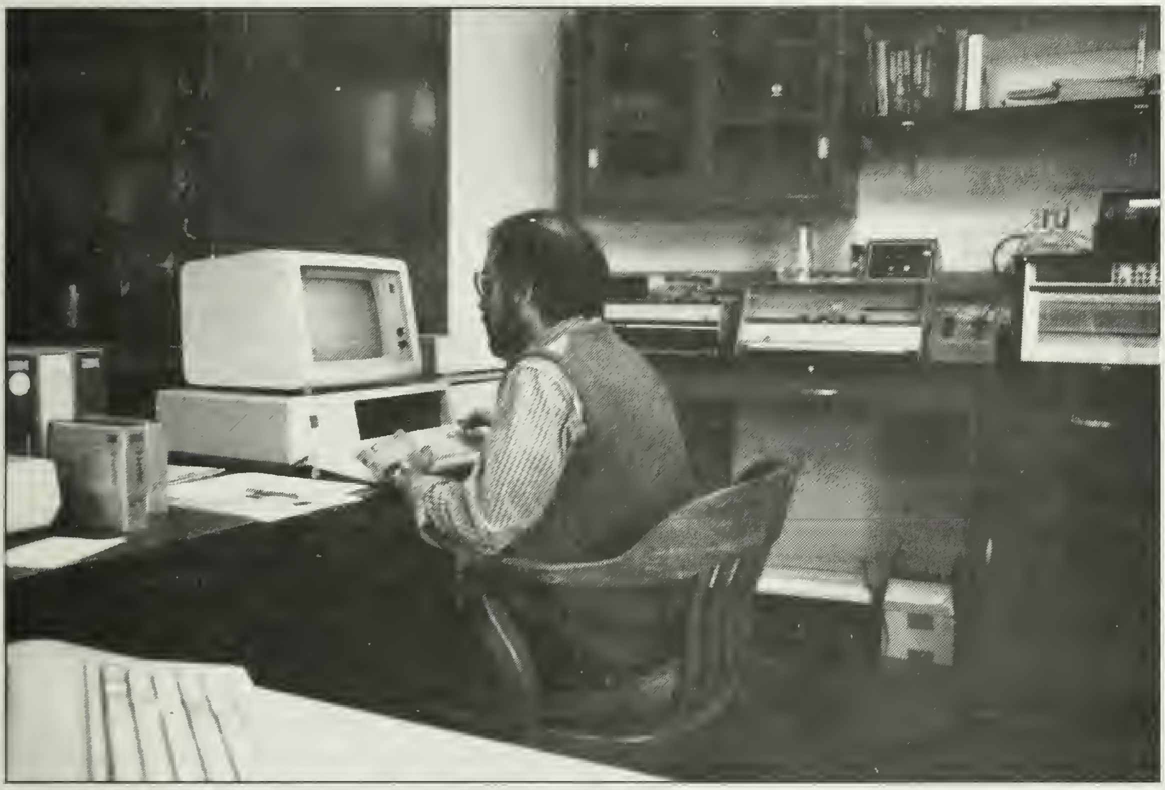


Figure 3. The thermogravimetric analyzer shown here is used to measure weight loss during heating of small samples. Computerized data collection and analysis allows samples to be compared in several different ways. Thermogravimetric analysis is an especially useful tool for studies of the effects of pyrolysis on coal: Massoud Rostam-Abadi, Minerals Engineering Section.

Automation of Thermal Analysis Instruments (Rostam-Abadi, Chaven, and Kruse). A computerized Thermal Analysis Laboratory that includes a Thermogravimetric Analyzer (TGA), Differential Scanning Calorimeter (DSC), and Differential Thermal Analyzer (DTA) is now in operation at the ISGS Applied Research Laboratory (ARL) (Fig. 3). In addition a Cahn RG Electrobalance is currently being upgraded to provide TG data on larger gram-size samples. Automation of the new laboratory and an adjacent analytical laboratory began in September 1983 with the purchase of two IBM-PC computers, a printer, and a plotter. Hardware for interfacing the instruments to the computers was delivered in December.

Maximum use of computing power in the new laboratory will require an extensive amount of softward development and several years of effort. To collect and store data from TGA and elemental anlayses, an initial software program has been installed, tested, and shown to be accurate, fast and user-friendly. Regression analyses and other statistical techniques have or are being designed to analyze data. Softward programs have also been developed for the analysis of thermogravimetric data. The effective kinetic expressions for decomposition and desulfurization of coal during carbonization are currently being calculated using this software program. This information can assist us in determining process parameters for operating our carbonization reactors, for scale-up of the reactors, for economic analyses, and for modeling and engineering design calculations.

Chemical Methods for Char Desulfurization (Griffin and M. Chou). The initial discovery that char prepared under specified conditions gave up its sulfur more readily than whole coal was made through chemical treatment of the char. We now believe that chemical treatment may be prohibitively expensive for commercial application; nevertheless, it is a very suitable laboratory means for determining why charring has rendered the sulfur extractable. We have found that an improved hydropyrolysis desulfurization rate in char after acid leaching is due in part to the conversion of strongly bound mineral sulfur forms to more weakly bound sulfur forms, mainly elemental sulfur in character. It was also found that a chemical reaction with hydrogen was necessary in order to remove strongly bound organic sulfur (thiophenic sulfur) forms from acid-leached char. The information obtained will provide a basis for more efficient and economical processes for desulfurization of coal char.

Chemical Characterization of Desulfurization Products from Coal (M. Chou and Griffin). This investigation is being conducted to determine the nature of sulfur structures (mainly organic) present in Illinois coal. This is a much-needed step in the development of any desulfurization process for high-sulfur Illinois coal. A systematic characterization of the coals is being conducted through analysis of the volatile matter and residual products produced from the charring of coal at progressively increasing temperatures.

Radioactive Tracer Study of Sulfur Removal During Low-Temperature Charring (Ruch, Auteri, and J. Frost). This is one of two investigations for determining the source of sulfur evolved by the low-temperature, counter-flow charring (desulfurization) process developed at the ISGS. Knowing which forms of sulfur in whole coal are volatilized and which remain during pryolysis is vital to continuing efforts to improve and upgrade methods for thermal desulfurization of Illinois coals.

Experimental work on the charring of coal containing radioactive pyrite ($Fe^{35}S_2$) was carried out from January 1983 through February 1984. Charring runs were made on coals containing a small amount of added radioactive pyrite, either (1) a synthetic pyrite prepared from iron and radioactive sulfur (^{35}S), or (2) an irradiated 1.6 specific gravity fraction from a coal. Because the pyritic sulfur in the feed-coal sample is radioactive, the fate of the pyrite in coal during the charring process can be determined by measuring the proportions of the radioactivity of sulfur recovered from the char and from the volatile products. A mean of 43 ± 5 percent of the radioactive sulfur was lost in charring; this is consistent with the decomposition of pyrite to pyrrhotite plus the sulfur evolved. A mean of 46 ± 5 percent of all the sulfur in the feed coal was lost, indicating that more than 50 percent of the organic sulfur in the coal was usually volatilized in charring. This is important, for it is the organic sulfur that is difficult to remove from coal without complete conversion.

Application of Natural Sulfur Isotope Variations to the Desulfurization of Illinois Coal (Coleman, Liu, and Hackley). This is the second of two methods for studying the reactivity of major sulfur forms (pyritic and organic) during the thermal desulfurization of coal. In this method, sulfur reactivity is determined by measuring variations in ratios of naturally occurring, stable sulfur isotopes found in organic and pyritic sulfur.

Three coals with suitable isotopic characteristics were selected for the stable isotope tracer study. One sample, which has a difference of 25°/₀₀ between $^{34}S/^{32}S$ isotopic ratio in the pyritic and organic forms of sulfur, has been studied extensively. Pyrolyses have been conducted at 550°C, 650°C, and 750°C, and a stepwise pyrolysis was completed from 350°C to 650°C. The results show that (1) total sulfur removal ranges from 52 to 60 percent with charring temperatures from 550°C to 750°C, (2) organic sulfur is preferentially removed relative to pyritic sulfur with charring temperatures below 500°C, and (3) pyritic sulfur removal becomes more significant at charring temperatures above 500°C. The fact that an excellent chemical and isotopic mass balance has been established through these experiments demonstrates that this isotope tracer technique is an accurate method for studying sulfur behavior during thermal desulfurization. Pyrolysis experiments have begun on two additional samples to gain further insight into the charring conditions most favorable for release of organic sulfur.

An Economic Assessment of Low-Temperature Charring (Stephenson and Kruse). The conversion of high-sulfur coals to clean solid, liquid, and gaseous fuels by coal pyrolysis appears to have some economic advantages over processes that produce only gaseous or liquid hydrocarbons (gasification or liquefaction). Among these advantages is the high thermal efficiency (85 to 90 percent). It was the purpose of this study to examine the partial economics of a hypothetical, coal-pyrolysis facility that processes 10,000 TPD of high-sulfur Illinois coal. The process, as presently conceived, is shown in Figure 4. Most of the process units beyond the gas/liquid separation are familiar operations in the

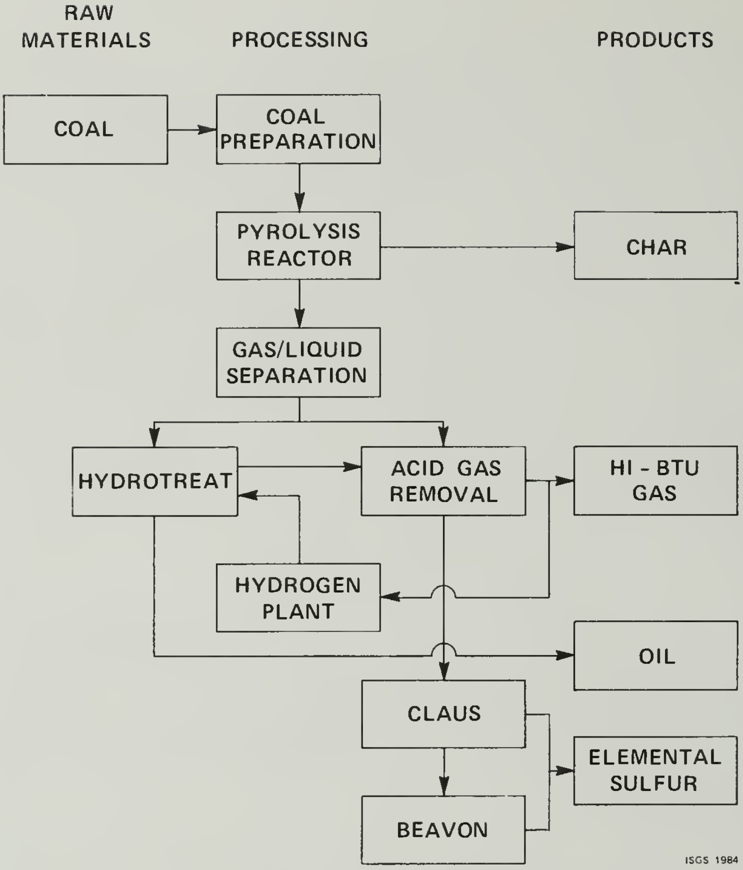


Figure 4. Process for Coal Pyrolysis Facility.

Table 2. Capital costs of a pyrolysis plant (1982 dollars).

Equipment	Cost $MM
Conveyors	.25
Storage	1.4
Crushing	2.5
H-Oil unit	44.9
Sour gas/a mine stripper	14.7
Hydrogen plant	15.4
Claus sulfur unit	11.5
Beavon tail-gas unit	8.9
Total	99.6

petroleum industry. Estimated capital costs of a coal pyrolysis plant are given in Table 2. Costs for a pyrolysis reactor and desulfurizer are excluded because reliable estimates depend on further technological development with these exclusions, the equipment costs are approximately $100 million.

A total capital investment of $300 to $400 million is indicated (including all indirect costs and working capital). From this amount, the capital available to profitably operate a charring and companion char desulfurization process can be calculated. The results of the economic assessment to date are consistent with the claim that pyrolysis facilities have substantially lower capital requirements than gasification or liquefaction plants. While we are encouraged by our findings, the technology to desulfurize char and burn it effectively still must be demonstrated.

Desulfurization of Illinois Coal by In-Situ Preparation of Iron Sulfide Catalysts (Shiley, Konopka, Foster, Cowin, Hughes, and Glass). This project concerns another method for reducing sulfur in coal. Like the project on low-temperature charring of coal, the goal of this investigation (in collaboration with Southern Illinois University at Carbondale) is to develop a desulfurization process for Illinois coal that is both economical and effective.

The catalytic properties of iron-sulfide minerals are being examined with special emphasis on processes related to desulfurization and to secondary reactants such as ethanol, which is likely to enhance desulfurization. The methods, previously developed but not routinely applied to systems in which iron sulfides (pyrite, pyrrhotites, and troilite) are the catalysts, have the capability to identify reaction products in complex mixtures, thus providing a means to specify the chemical processes involved.

The desulfurization process produces carbonyl sulfide from carbon monoxide and mineral pyrite in coal. This is followed by the reaction of hydrogen (produced from added ethanol) with the organic sulfur compounds in coal. It has been demonstrated that carbon monoxide can convert the pyrite in coal to pyrrhotite at temperatures as low as 250°C with the formation of carbonyl sulfide. We have shown that the reaction of carbon monoxide with pyrite is 10 times faster than that of hydrogen with pyrite. Main products of the process are a low-sulfur solid fuel and carbonyl sulfide, a valuable industrial chemical.

Fine Coal Cleaning (Buckentin, Kruse, and Ruch). The smallest coal particles yield the cleanest coals during physical methods of coal cleaning. Conventional gravity separations of fine coal are difficult, however, especially with Illinois coals, which are quite porous and tend to absorb the heavy liquids used in making separations. Also, as particle size becomes finer, surface phenomena interfere with gravity effects.

The Survey has developed a new coal-cleaning technique called aggregate flotation. It is being compared with other commercially-available coal cleaning methods, especially froth flotation and oil agglomeration to which it is related. Fine-sized coal particles (less than 28 mesh) are collected on surfactant-coated, micro air bubbles. The buoyant agglomerate rises and separates from the settling particles of mineral matter. To evaluate this method, equipment as well as samples have been obtained, samples prepared, and procedures developed for coal size reduction without oxidation. Preliminary optimization studies are being conducted. Although the preliminary results indicate a good potential for ash removal, a significant reduction of total sulfur has not been achieved. More developmental work is needed to understand the process and to effectively differentiate between pyrite and coal particles during the separation step.

Coal Sample Program (Stephenson and Kruse). The need for stable, standard coal samples is critical in coal research. Wide variations in results for the same samples frequently occur due to errors in sampling and changes resulting from exposure of coal samples to the atmosphere. One of the best ways to assure quality control for interlaboratory studies is through the comparison of results obtained from identical coal samples.

In its first meeting in 1982, the Illinois Coal Research Board (ICRB) expressed interest in funding a project to collect and store reasonably large samples of coal. The Board desired to assure the availability of a few of the coals used by the first year's ICRB contractors for work funded in subsequent years.

Arrangements were made with four mines to sample and obtain 3 tons each of 3 mine-washed coals and 1 1/2 tons of a tipple coal at a time when coal was moving from mine to cleaning plant without delay. Care was taken to avoid moisture loss during transport of the samples to the Applied Research Laboratory where the crushing, screening, and homogenization operations took place. After final homogenization was complete, the samples were placed in plastic lined 55-gallon barrels. The barrels were modified to facilitate purging with nitrogen (to prevent oxidation). Analyses for the four samples are shown in Table 3. Samples have been supplied to the contractors funded by the Illinois Coal Research Board and to a few other organizations wishing to participate in this coal sample program.

Table 3. Analyses of Coals in Storage

ASTM Analysis (As received)	Sample 1[a] C-22440	Sample #2[b] C-22424	Sample #3[c] C-22443	Sample #4[d] C-22538-41 Av.(Std Dev)
Moisture	13.7	13.4	5.0	10.2 (0.073)
Ash	8.5	5.6	7.9	34.2 (0.279)
Volatile matter	37.7	37.0	37.2	27.2 (0.144)
Fixed carbon	40.0	44.0	49.9	28.4 (0.222)
Sulfatic sulfur	.06	.42*	0.11	0.09 (0.0)
Pyritic sulfur	.94	1.33*	0.98	1.95 (0.054)
Organic sulfur	2.65	.96	1.53	1.62 (0.032)
Total sulfur	3.65	2.71	2.62	3.66 (0.066)
Free swelling index	5.5	4.5	4.5	2.5
BTU	10,903	12,630	11,562	7,660 (20.0)

[a] Herrin (No. 6) Coal from a west-central Illinois underground mine, collected June 1, 1983.

[b] Colchester (No. 2) Coal from a northwestern Illinois strip mine, collected June 23, 1983.

[c] Mixture of 80% Springfield (No. 5) Coal with 20% Herrin (No. 6) Coal from southern Illinois slope and strip mines, respectively, blended in the washing plant; collected July 15, 1983.

[d] Herrin (No. 6) Coal from a southwestern Illinois underground mine (unwashed) collected December 15, 1983; average analysis on four barrels.

* Highly variable because this coal is unusually susceptible to oxidation. The sulfatic sulfur is less than 0.1% when samples are not air dried overnight.

Miscellaneous Coal Research and Service

A significant portion of the Coal Section's work is devoted to answering requests for information on coal and coal-bearing strata. The requests come from private mineral owners, mostly farmers, from small coal operators or would be operators, from large coal companies operating or planning operations in Illinois, and from various governmental agencies. The responses vary according to the form of the request.

Telephone requests	1005
Letter reports	250
Office conferences	283
Field conferences and meetings	27
Public addresses	2
Press interviews	3
Government testimony	1

The Chemical Group, through its Analytical and Isotope Chemistry Geochemistry, and Minerals Engineering Sections, also provides numerous services relating to coal to the public, industry, and government agencies as well as to other sections at the ISGS: 3,400 determinations on 456 separate samples were provided during this report period.

OIL AND GAS

Economic Trends and Outlook

Oil and gas exploration in Illinois during 1983 experienced an overall 12 percent reduction in reported activity from the previous year. At the same time, 1983 crude oil production posted its fourth consecutive increase since 1963 (statistical details follow in sections A and B).

Compared to other parts of the country, where exploration for both oil and gas has dropped dramatically during the last 2 years, Illinois continues to bear up well under the impact of the current worldwide depressed price of crude oil. There are two reasons for this: (1) the lure of a successful new oil play at very shallow depths in Brown and Schuyler Counties, and (2) the average drilling depth in the Illinois Basin, which is shallow (2,600 ± feet) compared to 15,000 feet in parts of the southwest.

The exploration economics of the 2-year-old, ultra-shallow (650 feet deep) oil play in west-central Illinois east of Quincy continues to attract record numbers of out-of-state oil operators. To drill in this part of Illinois, more than 1,750 permits (30 percent of state's total) were issued during 1982. The area's two new oil fields, Buckhorn East and Brooklyn, had accumulated 1,100,000 and 125,000 barrels of oil, respectively, by the end of 1983.

Crude oil production in Illinois in 1983 was 29,200,000 barrels, 5.4 percent more than in 1982. Figure 5 shows the annual production history for the state.

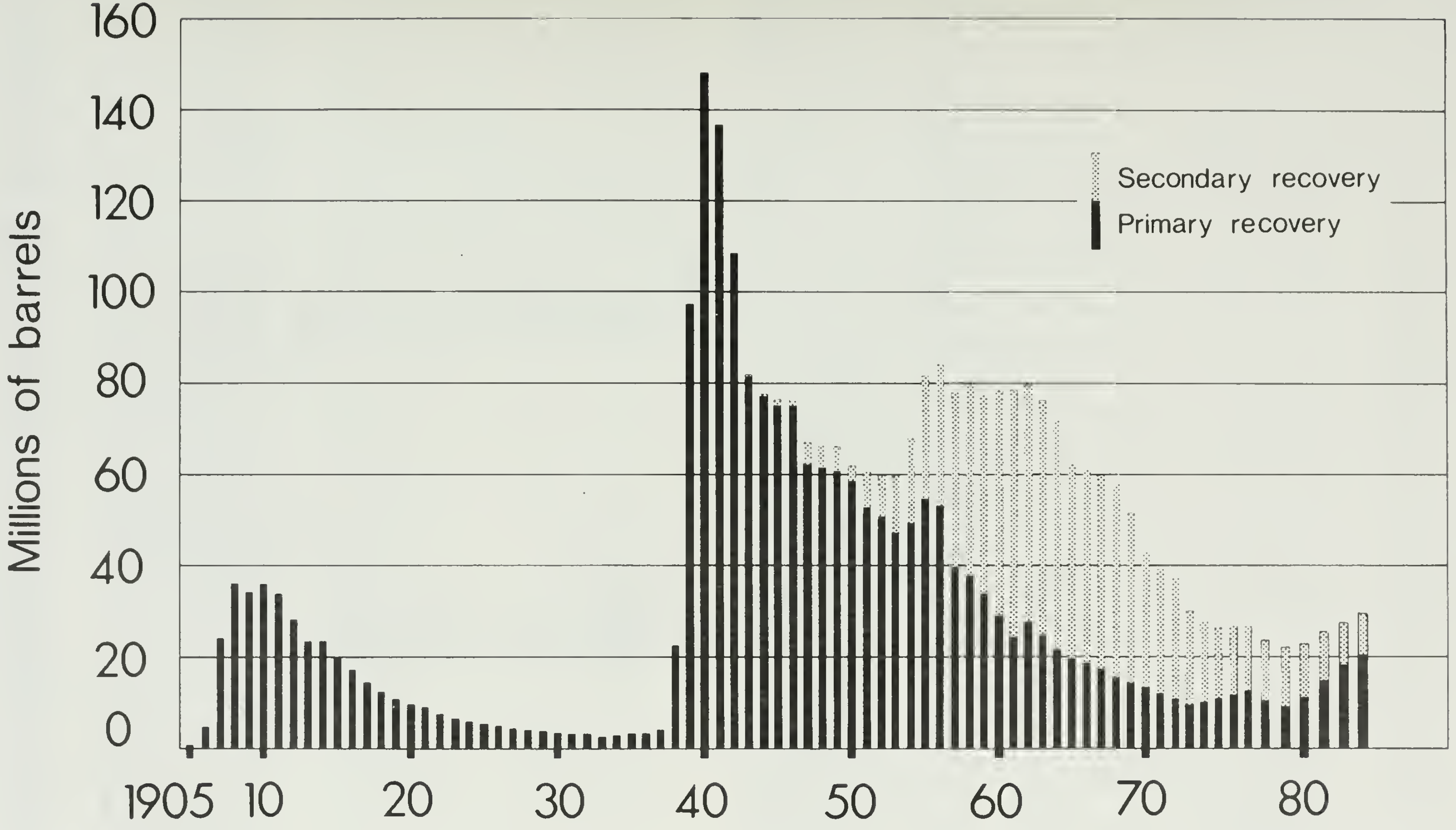


Figure 5. Annual crude oil production in Illinois.

Following is a tabulation of the number of holes reported drilled by the oil and gas industry in 1983 as compared with 1982.

	Number of Wells	
	1983	1982
Oil and gas tests		
New holes	2,625	2,955
Old holes drilled deeper	44	46
Service wells		
New holes	86	143
Old holes drilled deeper	1	0

As a number of drilling permits issued in 1983 was greater than in 1982, it appears likely that many wells drilled in 1983 have not yet been reported and that drilling activity in 1983 was probably equal to that in 1982.

The 2,624 new holes reported in 1984 resulted in 1,433 oil wells, 16 gas wells, and 1,175 dry holes for a success rate of 55 percent. The new wells were drilled in 54 of the 102 Illinois counties. The following 12 counties accounted for 67 percent of the new holes drilled.

County	Number of holes
Edwards	232
Brown	212
Crawford	204
Wayne	185
White	169
Clay	155
Fayette	118
Jasper	112
Lawrence	103
Wabash	94
Marion	87
Richland	86
	1,757

Total footage drilled by the oil and gas producing industry in Illinois in 1983, including service wells and structures tests, was 6,508,472 feet; 11 oil fields, 35 new pay zones in fields, and 50 extensions to fields were discovered in 1983.

Oil and Gas Program for Illinois

The Oil and Gas Program of the Geological Survey promotes the development of the petroleum resources of Illinois for the benefit of the state and its citizens. This requires comprehensive data collection as well as research to generate new ideas or new directions for current ideas and serves as a stimulus to petroleum exploration in the Illinois Basin.

Building, maintaining, and enhancing our geological data base involves the activities of the Geological Records Unit and communication between Survey geologists and petroleum industry operators and geologists--who provide the Survey with drill cuttings, diamond cores, crude oil and gas samples, seismic data, and other information pertinent to the search for hydrocarbons in Illinois.

Oil and gas data are made available to the public: (1) an annual report on the petroleum industry in Illinois; (2) a monthly drilling report; (3) oil and gas pay zone maps (showing the geographical areas underlain by oil production from individual rock layers); and (4) maps showing the elevation, with respect to sea level, of selected strata.

Survey scientists in turn use the Survey's geological data base to study and interpret the geologic and geochemical phenomena controlling petroleum generation, migration, and accumulation in Illinois. Current research projects are described in following paragraphs. The findings are presented to the public via Survey publications and other journals, talks to interested groups, and conversations with individuals visiting or calling the Survey. This interaction of people and ideas sparks new interest and insight into Illinois' hydrocarbon potential, which is economically important to all its citizens.

Petroleum Geology Investigations

Petroleum Geology of Lower Chesterian Sandstones in the Illinois Basin (Seyler). This research on stratigraphic traps in the sandstones and limestones of the Aux Vases Formation advances petroleum exploration in Illinois. It will provide a better understanding of the deposition and distribution of reservoir rock as well as the means to predict the location of reservoirs.

Stratigraphic traps (dependent on lateral changes in grain size and thickness of the unit) in the Aux Vases are very complex and consequently poorly understood. To delineate areas with the greatest potential for future production, the Survey has initiated studies of approximately 75,000 geophysical logs and many samples from cores and outcrops.

Shallow Petroleum Occurrence in West-Central Illinois (Seyler, Schwalb, and Howard). A 2-year, nationwide exploratory interest has focused on Silurian oil accumulations 450 to 650 feet deep in the area east of Quincy (mentioned earlier). There is demand for a plausible exploration model. Data necessary for developing such a model have been acquired during the past year, including 10 cores, 20 sample sets, and 700 gamma ray neutron logs.

Statewide Grid of Surface-to-Basement Lithologic Cross Sections (Schwalb, Seyler, Jacobson, and others). Illinois' deep frontier consists of a sequence of sedimentary rocks up to 2 miles thick, underlying a mile-thick section within which all exploration has occurred. What little is known of the petroleum potential of these deep rocks has come from a few deep tests and current Survey petroleum source-rock research sponsored by several major oil companies.

Work has begun on a network of 8 north-south and 6 east-west lithologic cross sections. Data for these sections are coming from well logs and drill cuttings. It is hoped that some industry-acquired proprietary seismic data may become available for coordination with and extrapolation of our well data. Greater knowledge of the deep subsurface conditions should lead to the generation of new "play" concepts, which in turn serve as incentives for industry to participate in exploring the deep basin.

Possible Meteorite Impact Structure in Southeastern Macoupin County, Illinois: Implications for Hydrocarbon Accumulation (Howard, Heigold, Kolata, and Nelson). A map showing the elevation of the floor of the long-abandoned Superior Coal Company Mine No. 1 southwest of Litchfield, Macoupin County, reveals a near-circular feature approximately 2.5 miles in diameter. The mine floor (and presumed base of Herrin No. 6 Coal) within the 1.5 mile-wide central portion of the feature rises to more than 65 feet above its elevation in the .5 mile-wide enclosing ring depression. The imposition of such a large and clearly defined structural anomaly upon a gentle, regional southeastward dip raises questions concerning its origin.

The central uplift and concentric ring depression suggest a pre-Pennsylvanian meteorite impact, which could have a wide range of implications with regard to oil entrapment, depending on when the impact occurred and the rocks it affected.

Source Rock and Migration Studies

Organic Geochemistry of New Albany Shale (M. Chou and Dickerson). Geochemical indicators might lead to a better knowledge of potential source rocks in deep formations of the Illinois Basin. To determine such indicators, one study deals with the characterization of organic matter in the New Albany Shale Group. Benzene extractable organic matter was characterized by chromatography and mass spectrometry. A study of core samples from a generally northwest-to-southeast cross section of the Illinois Basin shows that organic matter increases in maturity from the northwest (shallow) to the southeast (deep) portions of the basin. This agrees with microscopic vitrinite reflectance measurements routinely performed in oil basin studies.

Occurrence and Maturation of Sedimentary Organic Matter in the Illinois Basin (Barrows, Dillon, Schwalb, and Seyler). This 2 1/2-year old project (supported by Amoco, ARCO, Chevron, Marathon, Mobil, Pennzoil, Shell, Texaco, and Sohio) has amassed an important data base for further exploration in the basin.

The basic purposes of the study were (1) to identify and physically characterize potential hydrocarbon source beds, both within the currently productive upper 5,000 feet and the presently nonproductive sparsely tested, deeper strata; and (2) to determine where these potential source rocks were mature ("cooked") enough to have produced hydrocarbons. Vitrinite reflectance data supported by limited pyrolysis information has revealed geographical areas of mature source rocks where hydrocarbon generation has most likely occurred.

Organic Geochemistry of Illinois Basin Crude Oils and Possible Source Rocks (Risatti, Dickerson; with J. Hatch, Oil and Gas Division, USGS, Denver). This project just initiated, is concentrating first on characterizing Illiois Basin oils. Later aspects of the study will be concerned with the correlation of oils to their source rocks as well as with maturation, migration, and biodegradation of oils in the basin.

Major objectives are to match crude oil/source rock pairs and to provide basic knowledge of petroleum biomarkers as indicators of oil migration and maturation. The project interfaces with current research on novel archaebacterial lipids in petroleum, and is being conducted with the organic geochemistry group at the University of Bristol.

This study is being planned in cooperation with the Oil and Gas Section, which will work with geological controls and sample collection, and also with the cooperation of the USGS (Denver) Organic Geochemistry Group, which will perform certain chemical analyses. Oil samples stored at the ISGS and other oils that become available are being used. Rock samples will be obtained from the ISGS core library as well as hand samples and core material from other sources. Funding will be sought from industry for a 2- to 3-year study.

Composition of Oil and Gas

Oil and Gas Well Testing (Riley). The Oil and Gas Laboratory tested 28 gas and gas/oil wells within the past fiscal year. Gas flow rates were measured to aid operators in determining the commercial feasibility of producing from wells. Samples of natural gas were taken and analyzed quantitatively by gas chromotography to determine composition, specific gravity, and Btu value. This service is unique in the state, apart from the tests run by the major gas companies for their wells. As a result of our testing and consultation, natural gas that would have been flared or shut-in is now being put to use.

Of interest this year is the discovery of the Adams Gas Field. The first well was drilled in June 1983; since then, six more wells in the field have been tested by the Survey laboratory. Commercial production from the field should probably start in 1984-1985.

In addition to the gas well testing, this laboratory has also been involved in the Pittsfield Air Storage Research Project conducted by PB-KBB, Inc., to investigate the underground storage of compressed air as an electrical power plant peak-shaving method. The six deliverability flow tests performed by this laboratory on the air storage wells helped determine the feasibility of the project.

Biogeochemistry Investigations

Origins of Deep Sea Methane: Fractionation of Carbon-Isotopes by Methanococcus janaschii (Risatti and others). Investigators at the University of Illinois cooperated with Indiana University in this study of carbon isotope effects associated with the reduction of carbon dioxide by the bacteria Methanococcus jannaschii, isolated from East Pacific Rise deep-sea hydrothermal vent waters. Because of anomalously large concentrations of helium-3 and carbon-13 enriched methane found in rift zones and deep-sea hydrothermal vents, Gold has advanced the hypothesis that methane is abiotically formed in the mantle and reaches the surface through fault zones. Contrary to this, we hypothesize that a significant amount of the hydrothermal vent methane is of biotic origin, which can be demonstrated by determining the carbon and hydrogen isotope effects associated with methane produced by M. jannaschii.

To date, carbon isotopes have been measured in pure cultures grown at 70° and 83°C. We are currently growing cultures at 56° and 64°C to determine if carbon isotopic fraction by this organism is temperature dependent. We are also collecting gasses to determine if hydrogen isotopes are also fractionated. From these experiments, we hope to obtain basic information on the mechanisms involved in the formation of natural gas.

Temperature Effects on Macrocyclic Glycerol Diether Composition in a Deep-Sea Methanogen (Risatti and J. R. Maxwell, Organic Chemistry Group, University of Bristol, U.K.). The new, extremely thermophilic, deep-sea methanogenic bacterium Methanococcus jannaschii contains a novel macrocyclic, polar lipid in its cell membrane. The uniqueness of the lipid suggests that it may be useful as an environmental biomarker in crude oils and organic-rich sediments.

We are currently growing the organism at various temperatures (56° to 86°C). Lipids from the harvested cells will be studied using gas chromatography and gas chromatography-mass spectroscopy to determine if molecular and compositional changes occur with temperature changes.

Biogenic Acetate and the Origin of Natural Gas (Risatti and J. M. Hayes, Dept. of Chemistry, Indiana University). It is widely recognized that biogenic methane is much more depleted in carbon-13 than is thermogenic methane. However, the isotopic characteristics of the acetate-to-methane pathway, now recognized as the major source of sedimentary biogenic methane, are unknown. In this project the isotope fractionation related to the synthesis of acetic acid by bacteria is being studied to test the possibilities that (1) acetate is being produced in large quantities within methanogenic microbiological communities, and (2) the isotopic composition of that acetate is highly unusual and can readily be correlated with the isotopic composition of sedimentary biogenic methane.

We have completed experiments culturing acetogenic bacteria with carbon dioxide (CO_2) and hydrogen (H_2) as a substrate; the ^{13}C composition of the residual CO_2) and the resulting acetate methyl and carboxyl groups have been determined.

Our data indicate that biogenic acetate is isotopically fractionated with respect to carbon when it is produced from carbon dioxide and hydrogen. The magnitude of this fractionation and the carbon isotope composition of the acetate methyl and carboxyl group have been determined. These data explain the "anomalous" carbon isotope values found in sedimentary biogenic methane, which with further refinement may serve as an indicator of specific microbial activities in sediments.

Inhibition of Cellulose Degradation by Humic Acid (Risatti and W. A. Toscano, Dept. of Toxicology, Harvard University). Celluloses, which make up to 50 percent of the biomass of higher plants, are important additions to sedimentary basins. The microbial degradation of these celluloses is a primary step in the food chain, especially in anaerobic environments, which ideally terminate in the production of CO_2 and CH_4. Factors affecting the rate of this degradation require further study.[4] The rate, for example, is slow enough to allow thick accumulations of organic-rich materials such as peat, lignite, and coal deposits.

To determine if humic acids affect enzymatic degradation of cellulose, we performed experiments incubating these acids with cellulose and celluloses. Our data indicate that humic acid inhibits cellulose activity and decreases the rate of celulose degradation by up to 30 percent. Although we are not certain of the nature of the inhibition mechanisms, we do know that humic acid behaves as a polymeric inhibitor. The data suggest that humic-acid inhibition of cellulose degradation may explain in part the occurrences of deposits rich in plant remains.

Organic Geochemistry of Lipids from Methanogenic Bacteria (Risatti with J. R. Maxwell, School of Chemistry, University of Bristol). In this study, we are examining the distributions of lipids in various species of methanogenic bacteria by gas chromatography (GC) and GC-mass spectroscopy. The objectives are (1) to determine the importance of methanogenic lipids in petroleums, (2) to relate these lipids to those found in sediments, (3) to determine in greater detail the cell lipid components, (4) to relate these lipids to those found in some kerogens, and (5) to attempt to use methanogenic lipids in petroleum geochemistry as biomarkers indicative of anaerobic environments, bacterial source material and maturation, and migration.

A comparison of the methanogenic lipids with sedimentary components suggests it may be possible to distinguish whether some compounds (such as phytol) found in sediments originated directly from bacteria or mainly from plant sources. We have shown this to be the case with the Green River Shale (plant origins) and the Messel Shale (mixed origin). Thus terrigenous sources of organic-rich source rocks may be distinguished from marine environments.

Oil and Gas Statistics

Petroleum Industry in Illinois (Van Den Berg and Elyn). This annual report was issued as Illinois Petroleum 125 in April 1984. Part I summarized oil and gas developments; Part II dealt with waterflood operations.

Monthly Oil and Gas Drilling Report (Van Den Berg). A report of oil-and-gas wells drilled is supplied monthly to the petroleum industry, state and other governmental officials, landowners, and others interested in current oil activities. More than 500 copies are being distributed monthly.

Oil and Gas Developments in East-Central States in 1983 (Van Den Berg). A manuscript on developments in Illinois was combined with similar reports from Indiana, Kentucky, and Tennessee into one paper for publication in the Bulletin of the American Association of Petroleum Geologists.

Cooperation with Interstate Oil Compact Commission (Van Den Berg). A summary report on oil and gas developments is prepared annually for the Commission. An annual stripper well report showing number of wells, acreage, and production by fields is also prepared for the Commission.

Reports for Other Organizations (Van Den Berg). A detailed report on each well drilled in Illinois is made to the American Petroleum Institute (API), which gathers similar reports throughout the United States. These are the basis for statistical reports issued by the APE and the American Association of Petroleum Geologists (AAPG).

Other Service Activities

During the year, the Oil and Gas Section responded to 345 letters and 1,705 telephone inquiries from the public, industry, and government agencies. Also, 694 visitors came to the section, seeking information. Other services included analyses of 61 natural gas samples, involving 793 different determinations. In the area of public relations, staff members participated in four interviews with the press, including radio and TV appearances.

INDUSTRIAL MINERALS

Industry Activities, Trends and Outlook

During the past year, the general optimism concerning the national economy has been reflected in activities involving industrial minerals. For construction aggregates (stone, sand and gravel), the upswing has been augmented by recent state and federal tax increases on gasoline, earmarked largely for highway rehibilitation. The Illinois Department of Transportation expects FY 85 lettings to approach a level about 3 times that of FY 84; emphasis is on bituminous resurfacing. Much increased demand for aggregate will be met by reduction of present stockpiles, but there is renewed interest in finding and developing new deposits. Some sand and gravel producers and some limestone sources will have difficulty meeting tighter IDOT quality control specifications designed to reduce premature pavement deterioration, "D-cracking".

Business has also improved for the clay industry during the past year. Clay tile for field drainage systems was in great demand. Production of cat litter and oil absorbent clays continued at a high level; Absorbent Clay Products added an analytical laboratory to further their research and development efforts. Makers of brick, pottery, sewer tile, and refractory materials await further improvement in the economy to return to recent production levels. Interest in exploring for clay resources in Illinois increased substantially in the past year, primarily for near-market sources of absorbent clay, clays for covers and liners of waste impoundments, and kaolin.

Exploration continued in the Illinois portion of the Illinois-Kentucky Fluorspar District with core drilling activities in Hardin and Pope Counties. Also a permit for the extraction of silica by open pit methods was applied for within the Shawnee National Forest.

The Industrial Minerals Section is seeking funds for a comprehensive study of the industrial minerals resources of urban areas in Illinois, with special emphasis on the future accessibility of construction aggregate sources (crushed stone, sand and gravel).

Limestone and Dolomite

Urban Encroachment on Dolomite Resources of the Chicago Area (Mikulic and Goodwin). A preliminary study of the future crushed stone supplies for the Chicago area is in progress. More than 17 million tons of crushed stone were produced in this area during 1981, but urban encroachment on existing sites and lack of available new locations containing high-quality stone threaten this important Chicago mineral industry. The goal of the present study is to assess the situation for the present and future, indicate the general areas in which suitable stone may occur, and inform governmental officials and the public of the need to locate and protect new sources for the future.

Geology of Carbonate Aggregate Resources of Illinois (Goodwin). A report, published as IMN 87, considers the overall geologic setting of carbonate aggregate throughout the state and examines resources on the basis of statewide stratigraphy. Such a general synthesis was issued to promote further development of aggregate resources.

Rock Mechanical Properties of Quarry Stones from Illinois (Bauer, Fox, and Baxter). We determined the strength and sonic velocities of about 170 samples from 12 limestone quarries in Illinois and advised a heavy machinery company in the establishment of a testing program. This company was characterizing all stone quarries in Illinois recording the geology, strength, and sonic velocities of various mined rock materials--

part of their research in support of their machinery development program. The ISGS also provided information on all Illinois quarries: location, name and address of operator, and stratigraphy and lithology of stone being quarried.

Clays

Recovery of Kaolin and Fine Silica from a Tailing Pond of a Sand Washing Plant (Khan, Hughes, and Berggren). In an effort to promote full utilization of one of the state's mineral resources, the Survey examined the accumulation and processing behavior of clay and fine silica in an abandoned tailing pond. Kaolin occurs in small quantities in the St. Peter Sandstone in Illinois. During washing of this material, clay is discharged with fine silica into the tailing ponds. The recovery of these materials from the rejects will generate extra revenues and extend the lives of mineral operations.

Determination of the Distribution Pattern of the Sand Washing Rejects in Tailing Ponds (Khan, Berggren, and Hughes). The distribution pattern of material in the tailing pond of the sand washing plant was investigated. It was found that aerial photographs, taken for agricultural purposes in a sequence of years during the lifetime of a tailing pond, reveal distinctive vegetation patterns in the pond and can be used as exploratory tools to predict the distribution of the mineral constituents in the pond. A knowledge of the distribution of material helps in the design of an effective drilling scheme and saves on exploratory drilling costs.

Factors Affecting Comminution of Clays in Wobbling Grinder (Khan, Hughes, and Berggren). Materials that occur with clays may require scrubbing to remove the clay coating from their surfaces and to improve subsequent separation. During this operation the clay is ground to finer sizes. Grinding may also be required to upgrade the coarser, paper-filler clays to paper-coating grade. The scrubbing and grinding operations are cost-intensive because of their high-energy consumption and, therefore, must be carried out under optimum conditions. A wobbling grinder was used to determine the variables affecting the comminution of clays. It was found that the operational variables may be related not only to the type of the grinder but also to the nature of grinding media.

Bulk Mineralogy of Illinois Clays and Shales: Computer File of Test Data on Illinois Clays and Shales (Hughes). A computer file has been designed to store useful information on clays and shales in a readily retrievable form. The information can be used to locate particular types of clay resources, to correlate with engineering properties, and to study changes in composition resulting from depositional and post-depositional processes. For the most part, the file allows a rapid response to manufacturers that request a source of suitable clay for bricks, wall tile, flower pots, cement clay, cat litter, or similar products. This file grows by 1,000 to 3,000 samples per year.

Mineralogy of Clay Partings in Illinois Coals (Hughes, DeMaris, and White). The investigation of clays and shales associated with Illinois coals steadily continues. We are preparing a publication summarizing the origin and distribution of these materials. Results show that underclays and partings in coals were soils, but most of the soil formation in underclays resulted from plant growth before the establishment of the coal-forming swamp. Some underclays and most shales overlying coals are mainly unaltered deposits of detritus. Underclay composition is probably related to contemporaneous channel location, similarly to low-sulfur coal and nonmarine roof shale, which are also associated with the channels.

Periodic Visitation, Sampling, and Consultation with Illinois Clay Producers (Hughes). As time permits, we are continuing our visits to pottery manufacturers. Samples of raw material are usually collected so that a backlog of compositional data can be used to compare in case of future production difficulties.

Corrensite from Insoluble Residues of Limestones from Southern Illinois (Baxter, Hughes, and Glass). This study of insoluble residues is complete; the results will be analyzed and reported in the future. These residues contain an interesting suite of corrensite, smectite, illite, and well-crystallized chlorite and kaolinite. These analyses not only aid our understanding of limestone quality but also add to our knowledge of the depositional and post-depositional history of the rocks and the region.

Sand and Gravel

Geologic Characteristics of Illinois Gravel Deposits Affecting IDOT Freeze-Thaw Test Results (Masters and Evans). IDOT partially funded this cooperative research: laboratory work was completed this year. The study determined what rock types in Illinois, "Class A Quality" gravel aggregates contribute to the expansion of freeze-thaw test beams: 16 "Class A Quality" gravel aggregates represented all major gravel deposits that have been traditional sources of gravel aggregate for Illinois highways constructed with portland cement-based concrete. Freeze-thaw expansion data were analyzed relative to rock types. Univariate and multivariate statistical analyses of the data were made on IDOT and Illinois central computer systems using S.A.S. programs. These analyses indicate (1) dolomite content is not associated with expansion; (2) chert is the only abundant (consistently greater than 5 percent) rock type directly related to expansion; (3) minor rock types that cause expansion are silty dolomite, ironstone, and possibly weathered carbonate; and (4) sandstone-siltstone, conglomerate, and shale are suspected of causing significant expansion, but not at the low amounts in the study samples.

By applying this information, IDOT may modify its quality control specifications, resulting in the use of high-quality gravel aggregate for concrete highways, thus reducing deterioration and "D-cracking," and increasing the service life of the pavement. If aggregate producers know the rock types that are causing problems, they can develop processing methods to reduce the deleterious materials in their products. Selective mining can also avoid areas where the undesirable rock types are concentrated--when Class A products are being produced. Either or both of these techniques could help producers maximize the recoverable material in their reserves.

Geology of Sand and Gravel Aggregate Resources of Illinois (Masters). This report, published as Illinois Mineral Notes 88, points out that sand and gravel aggregates are relatively low-cost commodities at their point of origin; sources close to the point of use help hold down transportation and construction costs. Knowing where deposits are located is also valuable for multiple land-use planning. Advance planning provides for the most desirable, economical uses of land before and after aggregate extraction.

Fluorspar, Lead, and Zinc

Fluorite, the State Mineral of Illinois--A Handout Prepared for the Department of Mines and Minerals (Reinertsen, editorial staff, and Baxter). A one-page information sheet on fluorite was distributed by the Department of Mines and Minerals at the Illinois State Fair in Springfield.

Visitors from Pakistan (Bradbury and Baxter). The Survey was host to Messrs. Subhani and Jaleel, Deputy Directors of the Pakistan Geological Survey, December 12 through 14, 1983. Under the sponsorship of the United Nations, the visitors were in the United States to familiarize themselves with Mississippi Valley type ore deposits and to study exploration techniques employed in investigations of such deposits. The visitors were introduced to the geology of the southern Illinois fluorspar deposits during a field trip to the mining district and a tour of an Ozark-Mahoning flurospar mine. On December 14, discussions were held in Champaign on the zinc and lead deposits of the Upper Mississippi Valley District.

Processing of Barite and Fluorite Ores (Khan, Bradbury, and Baxter). Barite occurs abundantly in some fluorite deposits in southeastern Illinois. Recovery of barite from fluorite requires elaborate cleaning of the ore. Lack of information concerning the behavior of this ore during processing discourages exploitation of the resources. Earlier work at the Applied Research Laboratory with Humphrey's spiral indicated possibilities for barite-fluorite separation. To fund work in this area, a proposal has been submitted to the U.S. Bureau of Mines, upon the advice of a Mines official.

Other Industrial and Strategic Minerals Activities

Potential Agricultural and Industrial Uses of Lime Water-Softening Waste Slurry (Goodwin, Krapac, Reed, and Roy). The authors have completed a telephone survey to obtain information on the amounts of lime water-softening wastes produced annually at water treatment plants throughout the state. The results have been compiled. A map and inventory show the location of active treatment plants, the size of stockpiles, the annual production rate of slurry, the source of the softened water, and other data.

This inventory represents the first attempt to accurately determine the quantities of water-softening slurry available for agricultural use as well as the amount already being used.

Particle Size and Mineralogy of Selected Samples of -200 mesh Mineral Filler Aggregate (Goodwin and Hughes). In response to an inquiry from the Illinois Department of Transportation, studies were carried out to determine the particle size distribution and mineralogy of fine aggregate materials used as mineral fillers in bituminous pavements. Engineers from IDOT wished to determine whether clay minerals or other mineral contents or unusual particle size distributions might affect service life of pavements. Samples supplied by IDOT were analyzed with the Sedigraph to determine particle size distribution and by X-ray diffraction to determine mineral contents. IDOT received a written report. No peculiar minerals or particle size distributions were found.

Geologic Characteristics and Mineral Favorability of Basement Terrane and Sedimentary Cover in Illinois (Baxter, Schwalb, and Sargent). This is part of a program initiated by the U.S. Geological Survey to develop geologic methods for identifying new resources of strategic and critical minerals in both sedimentary and basement rocks. On January 11, H. Schwalb joined representatives of other state surveys at a meeting in Denver, Colorado, with personnel of the Branch of Central Mineral Resources (USGS): the Critical Minerals Program was discussed and state involvement invited. The major thrust during the first year, October 1983 through September 1984, will be an inventory of existing data within a large area of the Midcontinent, bounded by latitude 36°N and longitude 88° to 100°W. Approximately $100,000 is available for allocation to 10 or 11 states during the first year. No new research is anticipated in this initial stage.

ISGS will submit a proposal for about $8,500 to prepare a series of 1:500,000-scale maps indicating the general geologic characteristics and mineral favorability of the crystalline basement and the overlying sedimentary strata within the state. USGS will compile a folio of maps of the Midcontinent for publication at a 1:1,000,000 scale.

By-Product Mineral Recovery from Illinois Sand and Gravel Operations (Masters and Khan). The Survey received inquiries from a mineral-processing developer in Franklin Park concerning fine gold in Illinois. We arranged a field conference at a sand and gravel operation in the Chicago area. Waste streams were sampled at two of the company's sand and gravel pits. The Franklin Park group described their research on a method to recover very fine gold (less than 80µm median diameter), normally lost in gold placer mining operations. They are also interested in recovering any other heavy minerals of economic value that may be present, such as zircon and monazite. These components in Illinois sands are of such small grain size that a large proportion of them probably report as fines in the tailings. If results from our preliminary tests are favorable, further sampling of tailing deposits could follow--possibly initiating commercial recovery of mineral resources from materials considered to be waste.

Limited Occurrence of Gold in Illinois (Masters and Khan). There has been a persistent demand for information on the occurrence of gold in Illinois. To meet this demand, J. E. Lamar's unpublished report on the subject is being updated and expanded. Masters has confirmed the presence of very small amounts of gold in some Illinois sand and gravel deposits and has observed some accumulation in lower portions of screw classifiers at sand and gravel processing plants. Sample processing and analytical data will be included in the expanded report.

Mineral and Fuel Resources in Counties Adjacent to the Ohio River in Southern Illinois (Goodwin, Nelson, Treworgy, Baxter, and DuMontelle). At the request of the office of Attorney General Neil Hartigan, the Industrial Minerals, Earth Hazards and Engineering Geology, and Coal Sections of the Geological Survey prepared a report on the mineral and fuel resources in and adjacent to the Ohio River in Illinois. The Attorney General wishes to bring suit against the Commonwealth of Kentucky for the purpose of establishing a well-defined boundary between the two states.

Service Activities in Industrial Minerals

During the past year, the Industrial Minerals staff responded to numerous inquiries: personal visits (15), telephone requests (25), letters (25), and referrals from other staff members. Responses ranged from lengthy letters based on a search of literature or data on file to limited field or laboratory work. Inquiries generally concern past and present areas of mineral production and/or potential areas for future development.

Facilities for sample testing contain binocular and petrographic microscopes as well as equipment for thin- and polished-section preparation, crushing and grinding, particle-size analysis, heavy-liquid separation, and mineral identification by X-ray diffraction. The Survey's Applied Research Laboratory provides access to other mineral separation techniques.

MINERAL ECONOMICS

Activities of the Mineral Economics Section separate into two primary areas: 1) monitoring current Illinois mineral production (such as names and locations of mineral producers, kinds of mineral products, quantity and value of minerals produced; and 2) analysis of the various economic factors that govern mineral development and production in Illinois (such as mining costs, transportation, present and potential markets, and use patterns). Such information is important to public officials assessing the role of the mineral industry in the economy of Illinois, and to the mineral industry itself by identifying and evaluating factors influencing the health of the industry.

Projects

Directory of Sand and Gravel and Stone Producers of Illinois (Samson). This new directory lists Illinois sand and gravel and stone producers along with their geographic locations and postal addresses. The last directory was published in 1974. The present directory, updated in early 1984, contains information supplied by the Illinois Department of Transportation, the U.S. Bureau of Mines, and the ISGS staff. Storing the new directory on word processors permits easy updating. In the future, we hope to make up-to-date versions of the directory available to users upon request.

Lime and Limestone Market in Flue-Gas Desulfurization (Bhagwat). Flue-gas desulfurization (FGD) is the main commercially applied technology for SO_2 emission control. With the passage of the Clean Air Act in 1970, it was hoped that applications of FGD would proliferate rapidly, increasing demand for lime and limestone. The actual demand has fallen short of projections made in 1974, partly due to operating margins for coal burning utilities, and partly due to a rapid growth in production of low-sulfur western coal. This report first analyses the present clean-air regulations and their applicability to existing and new utilities, then projects the demand for lime and limestone in 1992. In a second scenario, the report assumes some form of acid-rain lagislation will be passed, forcing furthur SO_2 reductions from existing plants and damand for lime and limestone. Potential demand in the United States could reach 3.7 million tons per year for lime or 7.9 million tons for limestone, if no acid-rain legislation is passed--and 90 million tons for lime or 20.8 million tons for limestone, if acid-rain legislation is passed and implemented. Present demand is 0.9 million tons for lime and 0.56 million tons for limestone.

Illinois Mineral Industry in 1981 and 1982 and a Review of Preliminary Mineral Production in 1983 (Samson). 1982 production and value data are being compiled into a report. Preliminary 1983 figures will be added before publication. The report will contain production value and trend analyses of minerals produced or processed in Illinois.

An Analysis of Equipment Sizes Used in Illinois Surface Mines (Bhagwat). Equipment size can significantly affect the cost of production, and therefore the competitive position of coal in the market. Selecting the size of equipment in surface mines is not only based on amount of material to be moved, but also on other operating parmeters: for example, a safety factor accomodates occasional peak loads, mechanical breakdowns, and weather-related stoppages. For this report, we gathered data on equipment at 10 Illinois mines. Our analysis will compare the theoretical requirements with the actual use of equipment, work out the safety factors, and determine the correlation, if any, between costs of mining safety factors.

Economic Environment for Low-Temperature Charring and Desulfurization of Coal (Bhagwat and Johnson). This project, partially funded by the Coal Research Board through CRSC, will be incorporated into the final report on low-temperature charring (Carl Kruse, Principal Investigator). We plan to review results of past economic studies on low-temperature charring, assess price and demand levels for products resulting from the process and the price-elasticity of demand, and determine level of compliance with present and future clean-air regulations. The study aims to find the cost range (dollars per ton coal) that will support a viable desulfurization technology.

Economic Evaluation of Coal Mines Using Longwall Technology in the United States (Bhagwat). Data collection continues for the 80 to 90 longwall units operating in the country, 7 of which are in Illinois. Economic evaluation of longwalls should help assess future prospects for this European technology in Illinois. Its advantages are the higher extraction rates, safer working conditions, and reduced subsidence damage. Its disadvantage could be high production costs.

Service Activities

Telephone inquiries (175), letters (32), and visitors (10) seeking information and advice accounted for approximately 8 percent of working time in the year. Conferences with students and visitors from abroad (Germany) accounted for about 2 to 3 percent of the time.

GEOLOGICAL RECORDS UNIT

The Geological Records Unit (Fig. 6) is the legal repository for records of all drilling within Illinois: oil and gas wells, water wells, engineering borings, and miscellaneous test holes. The oil industry, coal industry, hydrogeologists, engineers, land-use planners, land owners, and the general public heavily rely upon this data base. The document files and well log books are constantly used by visitors and staff. A continued high level of drilling activity has increased the pressures on limited space and an outdated processing system.

Collections	1983-84	Total
Processed drill hole records	4,022	254,336
Books of processed drill hole records		749
Skeleton logs (records of wells drilled prior to 1945)		17,950
Skeleton log books		40
Confidential log books		15
Out-of-state log books		14
Miscellaneous hole record books		9
Geophysical logs	2,684	103,808
Coal permits	300	2,706
Coal pluggings	3,875	13,731
Filing numbers - Sample Sets	525	64,261
Filing numbers - Cores	77	12,878

Data Acquisition

Basic Data

Oil permits	5,750
Oil permit corrections	244
Water permits	4,936
Plugging affidavits (oil and water)	1,243

Logs

Electric logs	1,302
Micrologs	140
Radioactivity logs	1,051
Miscellaneous geophysical logs	191
Total geophysical logs	2,684
Drillers logs	425
Drilling time logs	429
Company sample and core studies	130
Geologic tops	270
General data (completion information)	1,685
Water well and test hole logs	2,791
Miscellaneous	167
Total new logs received	8,581

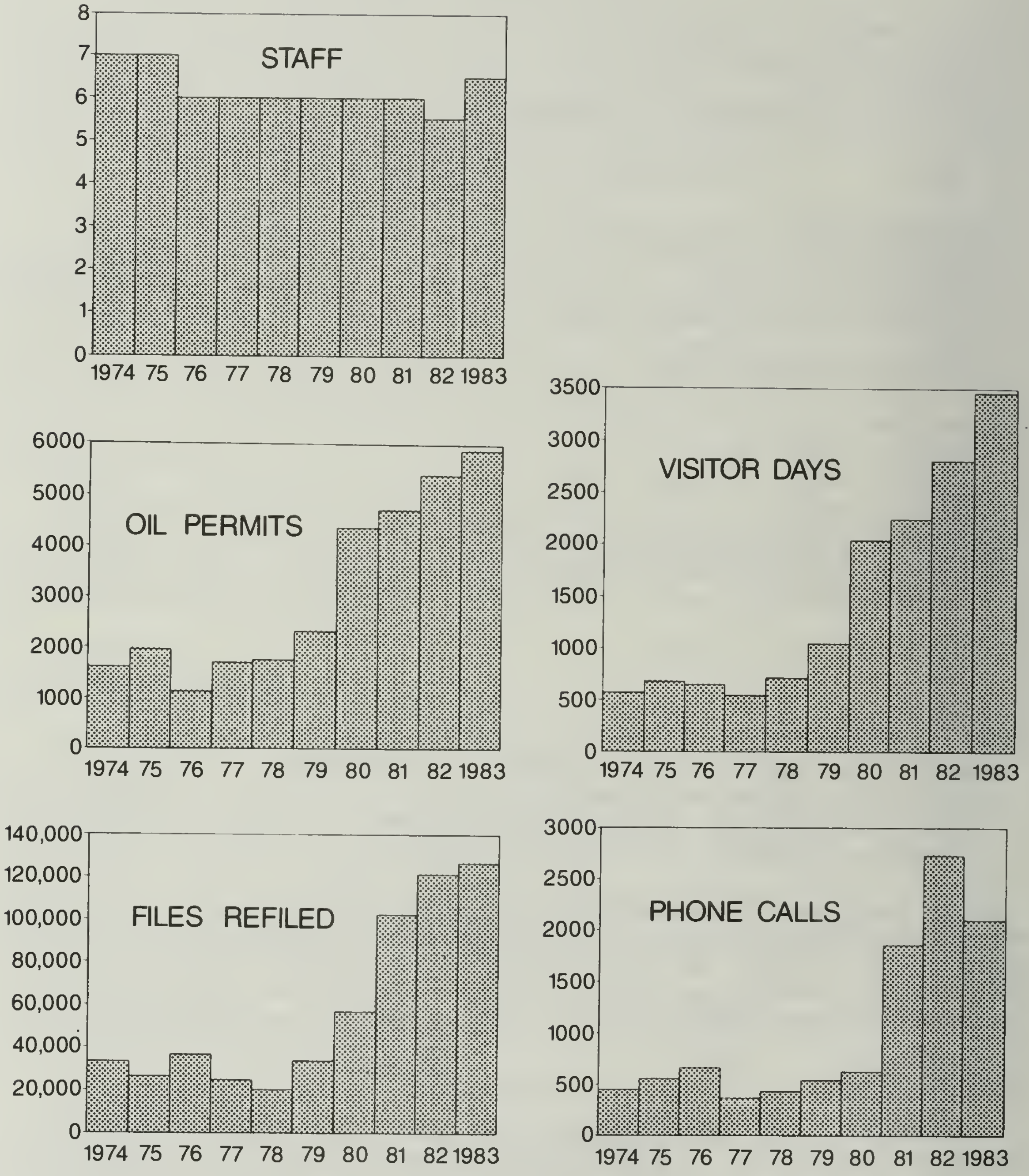
Backlog

Well files to be typed and placed in main files	2,767
Unprocessed water well records	20,000
Incomplete records, requests to companies	2,000
Plugging affidavits for processing wells	1,204

The continued high level of oil drilling in the state has increased the workload for the Geological Records staff. Time spent assisting visitors and callers, refiling records after visitors use, and processing incoming permits and logs has further reduced the time avilable for processing records, and requesting overdue logs and data from operators.

Computer Project

Automating the Geological Records Unit well inventory and cross-reference system will streamline the initial processing procedure and subsequent accessibility of incoming data. A Basic Data File already exists, containing 37 data items for most of the processed drill hole records in GRU files. A major portion of the Basic Data File has been transferred to the Prime computer. Streamlining of initial processing of data should have a positive effect on GRU operations by 1986.



Geological Records: graphical summary.

Figure 6. Geological Records Unit.

Service Activities Summary

	82/83	83/84
Visitor days	2,825	3,436
Letters	1,028	110
Files used by public and staff	123,893	125,173
Phone calls	2,718	2,321
Duplicate geophysical logs donated to the Illinois Oil and Gas Association	485	129

GEOLOGICAL SAMPLES LIBRARY

The Geological Survey began collecting samples in the early 1900s when the United States Geological Survey donated a series of drill hole samples to the State Geologist. As drilling activity increased in Illinois, so did the number of samples collected by the Survey. Today, the Illinois Geological Survey has one of the most unique sample repositories of all state geological surveys. The collection has grown to 64,256 sets of oil well and water well cuttings. These collections represent billions of dollars invested in Illinois by drilling companies over the years. Activities of the Geological Samples Library Unit for the past year follow:

Cuttings

525 sets of well sample cuttings (82 sets more than we acquired last year) were added to our permanent files. An additional 151 oil and water wells are awaiting processing. At the present time, there is about a 10-month interval between time received to time processed into our permanent files. Also, 394 oil well sets requested by the Survey are awaiting processing at the Evansville Sample Cut, a commercial firm, to which we subscribe. Additions to our permanent files were

(a) 169 oil test sets were received in butt form,
167 sets from rotary drill wells were washed,
2 sets from cable tool wells were processed dry;
(b) 224 washed sets were purchased from Evansville Sample Cut;
(c) 96 water well sets were received in butt form;
(d) 36 Geophysical Shot Hole test sets were received in butt form.

The sets of cuttings (representing more than 900,000 feet of drilling) cover 15 linear feet of space in the Sample Library. The Samples Library files of well cuttings (representing more than 738,250,000 feet of drilling) cover 1,385 linear feet in a 3,780 square foot area in the Samples Library.

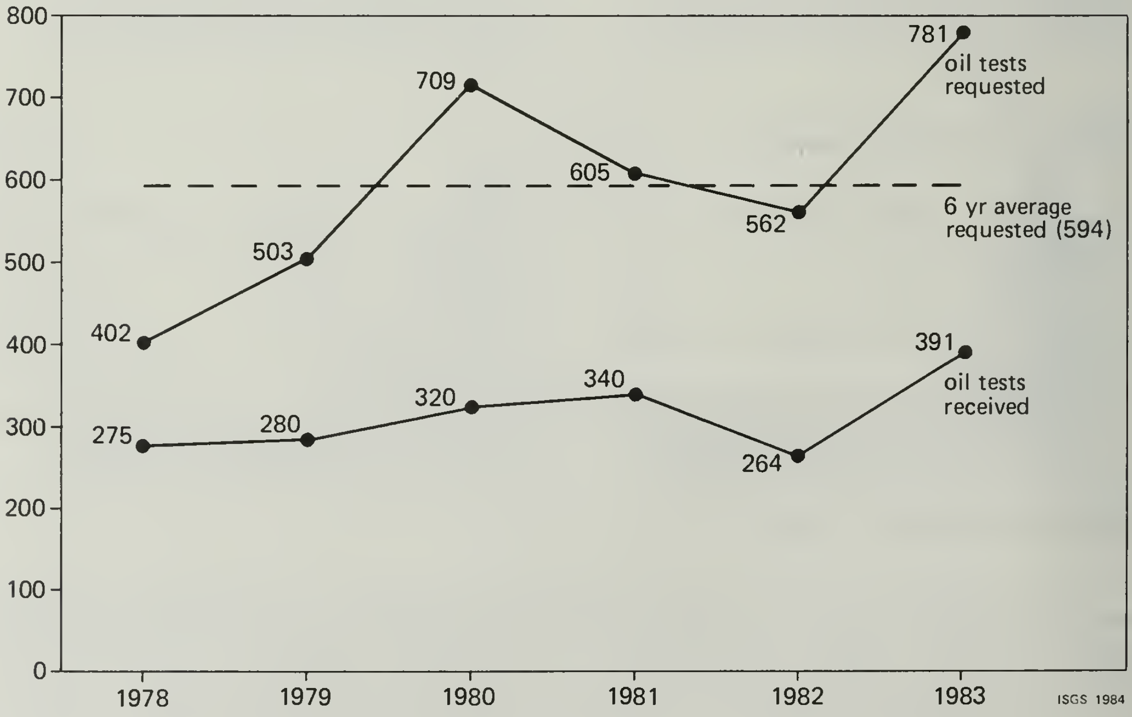


Figure 7. Oil tests requested relative to oil tests received.

The number of samples from oil tests requested by the Survey (781) is the highest in 15 years. We continue to receive about half of the well sample cuttings that are requested. Figure 6 indicates a 6 year pattern of oil tests requested and received.

Cores

During the past year, 77 sets of cores (most of them partially condensed from an initial 15,274 feet of drilling cores) were collected, examined, and processed into the permanent files. This represents an increase of 20 sets from last year's additions. To date we have on permanent file 12,879 sets of cores that represent more than 805,774 feet of core drilling. The entire collection of cores on permanent file is stored on steel racks in an area covering approximately 4,200 square feet of the Samples Library.

Other Sample Collections

During the past year, 341 Pleistocene (P-Series) samples were collected, examined, and processed into our permanent files. Our collection in this sample category now totals 23,351 individual samples.

Certain types of bulk samples that have undergone chemical analysis or were used as reference materials in research projects were added to the temporary files. There are 22,600 of these samples on temporary file in the Samples Library.

Supplies

The Geological Survey is required to provide sample bags for the collection of well sample cuttings that are requested by the State. During the past year the Samples Library supplied drillers and operators with 77,900 sample bags for requested well cuttings.

Summary of Service Activities

As drilling activity increased in Illinois during the past yar, so did requests for services of the Samples Library staff. Telephone requests regarding availability of samples or cores, location information, file numbers, and space availability to study samples are handled daily by GSL staff. The Samples Library Office contacts drillers by letter to inquire about delivery of samples from completed oil tests. During the past year, 219 such letters were sent to drillers and operators concerning cuttings from 317 oil tests. These letters generated 72 replies about the status of samples from 98 wells, and 22 additional oil tests were received.

During the past year visitors and staff members referred to our files 329 times and retrieved 989 sets of samples of cores for examination. A breakdown shows that (a) on 105 occasions 259 sets of samples or cores were examined by staff members at the NRB or Annex facility; and (b) on 224 occasions 730 sets of samples or cores were examined by

147 visitors to the Survey facilities. Visitors to the Annex facility represent a wide range of geologic interests. Independent consultants and representatives of major oil companies, universities, and governmental agencies are typical visitors at the Samples Library. Of all visitors to the Annex, 48 percent were from out-of-state:

54 (37%) independent Geologists		53 (36%) representatives of oil companies		40 (27%) representatives of universities and government	
In-state	Out-state	In-state	Out-state	In-state	Out-state
42 (29%)	12 (8%)	18 (13%)	35 (23%)	16 (11%)	24 (26%)

Visitors' states

Colorado
Indiana
Kansas
Kentucky
Louisiana
Michigan
Missouri
Ohio
Oklahoma
Pennsylvania
Calgary, Canada
Tennessee
Texas
Utah
West Virginia
Wisconsin

Government agencies and universities

Bradley University
University of Cincinnati
DePauw
University of Illinois
Illinois State University
Purdue University
West Virginia University
Indiana Geological Survey
U.S. Geological Survey
Southern Illinois University-Carbondale
Southern Illinois University-Edwardsville
University of Missouri
Monmouth College
Penn State University
Vanderbilt University
Illinois Department of Transportation
Wisconsin Geological Survey

Samples Library personnel annually assemble rock and mineral kits for distribution to Illinois schools. The labeled 35-specimen rock, mineral, and fossil set is a collection designed to familiarize teachers and students with the rocks and minerals of Illinois. This past year Samples Library staff assembled for distribution 130 specimen kits and have filled 17 orders to recondition sets already assigned to schools.

Industry Contributions

On January 13, 1984, Petroleum Information Corporation donated to the Geological Survey a micro-fiche reader and a micro-fiche collection of data from Illinois drill sites. The reader and collection were placed in the sample study lab at the Annex. The 62,673 individual fiche were inventoried and an index file was made. Since January 9, 1984, four visitors have referred to this collection 7 times and examined 15 fiche.

ENVIRONMENTAL GEOLOGY PROGRAM

Survey geologists collecting a sediment core from the Illinois River as part of a Long-Term Ecological Research (LTER) project: David L. Gross, Head of the Environmental Studies and Assessment Unit, and Richard A. Cahill, Analytical Chemistry Section.

ENVIRONMENTAL GEOLOGY PROGRAM

The Environmental Geology Program covers a broad range of citizens' concerns about their financial security, safety, and health in relation to the environment. The Survey developed the concept of environmental geology in the early 1960s; since then, it has become widely accepted. All projects are grounded in basic research--but focused on the application of geologic principles to environmental issues: studies of landslides, earthquakes, mine subsidence, groundwater supplies, waste management, and land use. The results of our scientific investigations assist government and industry as well as the public in making decisions and taking action to ensure that the quality of life is adequately preserved and protected.

The program has expanded from its original beginnings as geology for land-use planning to a broad based group. Projects of the past year are summarized in the following sections: Environmental Assessment Studies, Geology for Planning, Waste Management, Geologic Studies of Lakes and Rivers, Hydrogeologic Investigations, and Earth Hazards and Engineering Geology. These activities will continue under the newly organized General and Environmental Geology Group, directed by Keros Cartwright.

ENVIRONMENTAL STUDIES AND ASSESSMENT

To strengthen the areas of geologic assessment and analysis, an Environmental Studies and Assessment Unit was organized in February 1984. Under the direction of David L. Gross, the unit is building on strong federal support for the Long-Term Ecological Research (LTER) and Lands Unsuitable for Mining (LUMP) contracts. Although the Survey has a proud history in environmental geology, the previous approach to environmental assessment was through committees: individual scientists were responsible both for basic studies and for environmental applications and/or implications. A new unit, a direct assignment of staff, and the opportunities afforded by the Geographic Information System on the Prime 750 computer have made it possible to undertake major projects: for example, environmental screening for the Fermilab siting study--a significant project summarized later under Geology for Planning.

Illinois Lands Unsuitable for Mining Program (LUMP)

Rice Lake Report (McKay and Krumm). Responding to a Lands Unsuitable petition filed by a citizens group, the Environmental Studies and Assessment Unit provided significant input to the first Department of Energy and Natural Resources (DENR) Land Report. The lands unsuitable for mining designation was sought for the Rice Lake Conservation Area in Fulton County. The ISGS prepared a detailed geologic inventory including maps, tables, and cross sections; the data covered surficial and bedrock geologic units as well as sand and gravel resources. Of major significance was an evaluation of the coal deposits at the site and of the potential constraints for mining the area.

Prime 750 Computer and Associated Software Capabilities (McKay, Gross, Krumm, and many others). Through the LUMP program, DENR maintains a natural resource information system and data base for use in development of Lands Unsuitable petitions. To increase the availability of the large amounts of data that DENR has, selected data are being automated and entered into a Prime 750 computer. The computer will also be used in the production of land reports for petition areas. At present, the Prime 750 and associated hardware allow digital storage and rapid retrieval of (1) large statewide maps, (2) very detailed local or regional maps, and (3) tabular data such as well logs or census formation. These data form the core of the LUMP GIS (Geographic Information System), which is expanding rapidly with new data from the Geological Survey, other DENR divisions, and the Environmental Systems Research Institute (ESRI)--the principal consultant to LUMP for data base creation and management.

Within the ISGS, remote devices installed and now operating on the PRIME 750 system include one general purpose CRT, two graphics CRTs, one large digitizer, and one printer.

Geological Map Data Bases on the Prime 750 System (McKay, Krumm, and Gross). Map data are being converted to automated form and entered into the Prime 750 natural resource data base by the Lands Unsuitable program. These data include both statewide maps (1:500,000 scale) and local or regional maps (1:40,000 and 1:62,500 scale). Geological Survey data incorporated into the statewide data files include (1) bedrock geology maps, (2) quaternary deposits maps, (3) stack-unit maps of shallow geologic materials, (4) glacial boundaries, (5) surface coal mine locations, (6) underground coal mine locations, (7) structural features maps showing locations of major faults, (8) resources of the Springfield (No. 5) Coal, (9) resources of the Herrin (No. 6) Coal, (10) loess thickness maps, and (11) glacial drift thickness maps. At the detailed map scales, the following geologic data are being entered: (1) landforms (1:40,000), (2) slope (1:400,000), (3) soils (1:40,000), and (4) strippable coal resources (1:62,500). Mapping is in progress at the 1:40,000 scale for an area of approximately 1,000 square miles in the southern Illinois coal fields. The 1:62,500 mapping will cover approximately 6,500 square miles in the strippable coal region of southern and western Illinois. Map automation is being checked rigorously to assure quality. The auotmated map files will support rapid retrieval and reformating of maps for use in publications, reports, or responses to requests from the public. Furthermore, the map data bases will support computer modeling to produce interpretive maps such as hazard, capability/suitability, or condition maps, streamlining the traditional manual methods.

Geological Tabular Data Bases on the Prime 750 System (McKay, Krumm, Gross, and DuMontelle). Tabular data bases, consisting of text and numeric data, can be geographically referenced as attributes of map units in the map data bases or as attributes or features associated with lines (faults) or points (well locations). Lands Unsuitable has made a major effort to reformat the Geological Survey's Basic Well Data File (BWDF). This file contains records from approximately 200,000 wells drilled in Illinois. These geographically referenced point data have been placed on the Prime 750 computer and can be used to sort and select the record of any specific well or group of wells based on their depth, location, well type, well driller, samples collected, logs run, or any other attributes.

Also underway at present is an effort to design automated tabular data files for storage (1) expanded interpretive geological data for wells, (2) an index to Coal Section files, (3) mine data, (4) an index to engineering and landfill reports, (5) coal stratigraphic data, and (6) coal resource data.

ILLIMAP Update (Environmental Studies Unit and Environmental Systems Research Institute). The ILLIMAP computer file of section and township line coordinates has been converted to be compatible with software in use on the Prime 750 computer. Programs are being written by the Environmental Systems Research Institute (ESRI) to allow easy user interaction with ILLIMAP. This will facilitate the use of ILLIMAP to produce basemaps on which data from the statewide (1:500,000) or the detailed (1:40,000 and 1:62,000) Lands Unsuitable map data can be drawn. It will also allow well data from the Lands Unsuitable conversion of the Survey's Basic Well Data file to be plotted on base maps on paper or at a graphics terminal.

Lands Unsuitable is also updating the ILLIMAP file by digitizing coordinate data from more than 400 new 7.5-minute topographic maps published since the original ILLIMAP file was created.

Training on the Prime 750 System (McKay and 13 others). A major effort has been made by the Lands Unsuitable Program to train Survey personnel in the use of the Prime 750, its software, and the GIS data base. Six training courses have been conducted by the Lands Unsuitable consultants: software, mapping, modeling, word processing, advanced software, and advanced methods. Between September 1983 and February 1984, both LUMP and non-LUMP staff devoted 28.8 weeks to this training. Furthermore, six other non-LUMP Survey staff have been given approximately 8 weeks of training by Survey LUMP staff. Training will continue in an effort to assure the successful incorporation of the GIS capability into the Lands Unsuitable program and into the Geological Survey's research and service.

Long-Term Ecological Research (LTER)

Ecological Structure and Function of Major Rivers in Illinois (Gross, Cahill, Autrey, Casavant, and McKay). The U.S. National Science Foundation has funded a network of 11 Long-Term Ecological Research (LTER) sites in a wide range of ecological habitats. The three Surveys and Western Illinois University designed a family of major research projects on three sites: Pool 19 of the Mississippi, a relatively pristine site; Pool 26 of the Mississippi and Illinois Rivers, a site expected to change; and Peoria Pool of the Illinois, a highly disturbed site. The geological portions of LTER include geologic mapping, sedimentology of whole pools (45-mile reach of the Mississippi), sedimentation rates (with special reference to organic carbon loss to sediments, part of modeling the flow of organic carbon in large systems), isotopic dating of sediments, and fate of pollutants in river systems. We are beginning the third year of work in a 5-year grant.

Automation of Maps for LTER (McKay, Black, and Gross). The boundaries of the Mississippi River, islands, backwater lakes, geologic maps, and sampling locations for work of all three Surveys have been digitized for nine 7.5-minute topographic maps in Pool 19. We plan to automate maps of biological parameters such as plant beds, then make area calculations leading to modeling of the pool. This project, using the PRIME 750 system and the large digitizing board in the ISGS, is a prototype--testing the effort required to put maps into machine-readable form. Procedures developed for this project should apply directly to Lands Unsuitable for Mining (LUMP).

GEOLOGY FOR PLANNING

The Geology-for-Planning Program is a geological approach to resource-based land-use planning. By mapping the vertical as well as the areal distribution of geologic materials, and by reporting the physical characteristics of these materials, we can evaluate how suitable any area is for burying wastes, finding water supplies, building houses and roads, excavating quarries, or constructing major industrial complexes. Our maps and reports provide valuable information to planning agencies in industry and in government--both state and local.

Recently, our staff completed a geology-for-planning study of Boone and Winnebago Counties; we produced 11 maps that will help them evaluate their region. Both counties contributed funds and personnel to this cooperative project. Currently, the Survey is involved in another major project: Fermilab, a study of the geologic feasibility for siting the 20 TeV accelerator near the present Fermi National Accelerator Laboratory at Batavia, Illinois.

Fermilab

Geologic Study for Siting the 20 TeV Accelerator in Illinois (Kempton, Hannah, Vaiden, Kolata, DuMontelle, Killey, and Bauer). At the request of Dr. Leon Lederman, Director of Fermi National Accelerator Laboratory, Batavia, Illinois, the ISGS and Fermilab staff are developing information needed to evaluate the geologic feasibility of locating a 20 trillion electronvolt (TeV) super conducting colliding beam accelerator ring (SSC) in northeastern Illinois near Batavia. The ring could be up to 30 miles in diameter. Several states are competing for this $2 to $3 billion project with world-wide significance for high-energy physics. The economic significance for the state, if Illinois is selected as the location of the SSC, will be considerable. During a meeting with Dr. Ledermann on December 2, 1983, Governor Thompson expressed his commitment to bringing the accelerator to Illinois; he has requested a special appropriation for the Geological Survey to complete the study.

The ISGS study initially consisted of three phases. Phase 1, a preliminary feasibility study is complete. The report includes a color illustration of the proposed accelerator ring--30 miles in diameter and 100 miles in circumference. Phase 2 consists of a detailed examination of all available surface and subsurface data to locate the most suitable area for the corridor (the circular area that will eventually contain the ring). Phase 3 includes a test drilling program to verify the geologic conditions and to further restrict--not precisely select--the area within the corridor that best fits the criteria for constructing the ring. Clearly, the geologic study is essential to the engineering of the project--the basis for the project design.

Fermilab also requested all three Surveys and the State Museum to assist with the enviornmental screening of the area. The ISGS will coordinate the screening activities through the Environmental Studies and Assessment Unit.

Surficial (Stack-Unit) Geologic Mapping for the Fermilab Project (Berg). Geologic mapping is part of Phase 2 of the Fermilab project; it will also contribute to the ISGS portion of the environmental screening study. In this project, vertical sequences of geologic materials from the surface to bedrock (stack units) will be mapped in detail, covering the area proposed for the 100-mile circumference particle accelerator ring. Mapping includes Kane, De Kalb, the easternmost township of Ogle and Lee, and the northernmost township of Kendall Counties. Preliminary maps to date have been completed showing the geology in the upper 5 feet. These were made from soil survey sheets of the area.

Fermilab - Design of Project Automation (McKay, Gross, Krumm, and Kempton). Using the Prime 750 computer, Survey staff are designing techniques for handling data for the Fermilab project. The present design calls for (1) production of base maps showing locations of geologic observations and boreholes, (2) encoding and automation of interpretive geologic information for approximately 2,500 wells in the study area, (3) plotting of selected well data, such as drift thickness, on base maps, (4) interrogation of existing 1:500,000 Lands Unsuitable data base for preliminary site screening, and (5) automation of geologic map products for graphic display and modeling of land capability for siting.

Other Projects

Engineering Geology of Chicago (Dixon and T. R. Maynard, Chicago Dept. of Public Works). This paper for the Bulletin of the Association of Engineering Geologists is expected to be completed in January 1985. It will be part of the series, Geology of the Cities of the World. The discussion includes the geologic factors that have affected the growth and development of Chicago and the geotechnical methods used to found structures and mitigate various environmental constraints.

Sources of Information on Engineering Geology and Related Topics for Northeastern Illinois (Dixon, Dowding, DuMontelle, Foster, Hurley, Maynard, and Vanderpool). This resource document, recently compiled and currently under review, indicates the basic data and services available in northeastern Illinois. It was produced jointly by the Geotechnical Division of the Illinois Section of the American Society of Civil Engineers and the North-Central Section of the Association of Engineering Geologists, in cooperation with the Illinois State Geological Survey.

Service Activities

The geology-for-planning staff provided information to 35 visitors and responded to 68 telephone queries and 29 letters. The group also completed 33 groundwater reports, logged 44 wells on a service bases, and issued 27 reports containing requested sample anlayses.

WASTE MANAGEMENT

Illinois is one of the largest producers of "hazardous" and "non-hazardous" wastes in the United States. Means of safely and economically managing these wastes must be found.

The Survey's program of waste management is interdisciplinary, incorporating several geologic and chemical specialities. It began in the early 1960s and has expanded, absorbing the major efforts of two sections and parts of several other programs. Outside funding for these activities has supported our already considerable effort.

The ISGS joined the other two surveys, the State Museum, and DENR's Springfield Office to propose a new legislative initiative on hazardous waste. The governor's office supports the proposed Hazardous Waste Research and Information Center. In addition, the Legislature and the Attorney General formed a Hazardous Waste Task Force, which includes Survey representation. This task force will be making recommendations to the spring 1984 legislative session. It appears likely that a major new effort will be funded and underway by the end of the year.

Landfills/Septic Systems

Potential for Contamination of Shallow Aquifers by Land Burial of Municipal Wastes and Surface and Near-Surface Waste Disposal (Berg, Kempton, and Cartwright). This report, completed last year and now ready for publication, rates areas of the state for potential contamination from waste disposal facilities and practices. Areas most sensitive to contamination are underlain by fractured and permeable bedrock, or sand and gravel. Least sensitive areas are underlain by thick glacial till or dense bedrock. The project was partially funded through the Illinois Environmental Protection Agency.

Use of Batch Adsorption Procedures for Designing Earthen Liners for Landfills (Ainsworth, Krapac, Roy, S.F.J. Chou, and Griffin). The Survey is developing procedures to perform routine batch adsorption measurements for use in conducting reliable and reproducible tests for pollution adsorption by earth materials. ASTM member laboratories are providing guidance and assistance with the testing. The variation of adsorption capacity between laboratories has been narrowed from greater than 100 percent to a worst-case 10 percent coefficient of variation. During the investigation, the need for a standard mixing apparatus became clear.

Other investigations are leading to standard methods of determining the length of time necessary to achieve steady-state conditions for adsorption of pollutants as well as the most appropriate solid-to-solution ratio for a given soil-water-pollutant system. We are also studying the effects of competitive adsorption and how this phenomena may influence the results from batch adsorption procedures. During the first year of this phase of the investigation, data from binary solute systems involving two of the three oxyanions (arsenate, molybdate, and phosphate) show that the presence of any one of these anions will influence the amount of adsorption of the others. Mathematical models are being applied to competitive systems to ascertain predictive capabilities. This work should improve our ability to interpret the results from batch adsorption studies.

Hazardous Toxic Wastes

Investigation of Failure Mechanisms and Migration of Industrial Chemicals at Wilsonville, Illinois (Griffin, Cartwright, DuMontelle, Follmer, Stohr, Johnson, Killey, Hughes, S.F.J. Chou, Bartz, Steele, and Harvey). In March 1982, the Illinois Supreme Court ordered the exhumation and removal of wastes at a hazardous waste-disposal facility near Wilsonville, Illinois (Macoupin County). The reason for the order was leakage of contaminants and potential for harm to Wilsonville from continued operation of the site. The order provided a unique opportunity to examine the effects of industrial chemicals on soils below and adjacent to the site and to measure migration of contaminants from the trenches.

The cooperative study of the site involves several agencies as well as the site owner. The US EPA has largely supplied the funding through an agreement with the ISGS, whose specialists are performing most of the work. The Illinois EPA has provided a drill rig and crew for the field studies and is performing organic analyses on soil and water samples from the site. The site owner, SCA Services, Inc., has provided access to the site, safety training, and many of the materials for constructing the monitoring wells and piezometers.

During the first year, soil borings, installation of monitoring wells, and a thorough geological investigation were completed. Analyses of water, leachates, and soil samples are continuing, together with the hydrogeologic investigation. Examination of samples from the soil borings and observations in backhoe pits at the site indicate that sandy layers within the clay till are not continuous, thus do not account entirely for the contaminant migration. The full significance of discontinuities and joints exposed in the till by backhoe pits and angle-hole drilling remains to be determined, but they result in increased hydraulic conductivity--accounting for the contaminant migration.

Also under investigation is the sealing efficiency of natural landfill liners and covers, which consist largely of clay minerals. Results obtained to date show clearly that hazardous waste materials cause clays to crack. In fact, most natural clay materials have major crack systems. The greatest problem at sites such as Wilsonville is caused by agents that are immersible in water and are not attenuated by clay minerals. These hydrophobic agents pass rapidly through developing or existing cracks and other avenues of flow. Clays that develop very impermeable barriers in water have been shown to be especially vulnerable to waste-induced failure. These unexpected results suggest a complete revision in the design and choice of materials for landfill disposal of hazardous organic wastes.

Petrography of the Vandalia Till at the Wilsonville Hazardous Waste Site (Harvey and Brandabur; in cooperation with Griffin, Stohr, and others). In addition to investigating the clay mineralogy, we are studying the petrographic texture and structure of the till at the Wilsonville site. Barrels containing the chemical wastes are buried in this till. The microscopic data may help delineate mechanisms of reaction between the liquid wastes and the till.

To date, apparatus has been assembled to saturate samples of the till with epoxy for thin-section preparation; a set of 7 samples was collected at the site for microscopic examination. Special fluorescence analysis by microscopic techniques are planned to help determine whether or not organic solvents, the main type of waste at the site, had passed through the sample of till.

Remote Sensing Techniques for Trouble Areas at Hazardous Waste Sites (DuMontelle and others). Thermography, aerial photography, and close-range photogrammetry were used at Wilsonville. On the basis of thermography, landfill trench-cover depressions that rapidly recharge the subsurface (trenches) were distinguishable from depressions that puddle at the surface, permitting only minor recharge. It was also used to differentiate drums of PCB wastes from other drummed wastes; the PCBs were about 30°C warmer.

Comparison of black and white aerial photographs with standard, 1-foot contour, topographic maps of hazardous waste landfill covers revealed the superiority of the photointerpretation for identifying closed and open depressions not observed in the field. Field personnel found six depressions, the topographic map shows four depressions, and 35 were found by photointerpretation.

Last, close-range photogrammetry (making measurements from photographs) was used to measure and document joints and fractures in backbone pits at a hazardous waste site near Wilsonville, Macoupin County.

Stereoscopic photography (3-D viewing) performed more precisely and safely in making these measurements.

Prediction of Soil Mobility of PCBs from Sorption Coefficient (Chou and Griffin). The soil sorption coefficient of a chemical has been recognized as a major factor controlling its mobility; however, confidence is lacking that this measurement is the sole means for estimating mobility. Column leaching experiments were conducted to correlate the soil sorption coefficient (K_d) with movement. Soil columns, eluted under controlled conditions and water and water/organic solvent mixtures, were studied with Aroclor 1242 (PCB) and three types of soils. Mathematical modeling of the velocity of the chemical front was attempted. A preliminary result suggests that the velocity of the chemical front can be predicted and that the service life of a land-disposal site for PCBs can be estimated.

Effects of Organic Solvents on the Solubility and Sorption of PCBs by Earth Materials (S.F.J. Chou, Redding, and Griffin). Disposal of PCBs and related materials by land burial has caused great concern because of possible groundwater contamination. Although considerable effort has been expended to document the various aspects of environmental contamination by PCBs, their transport mechanisms in the environment are still poorly understood. In this study, Aroclor 1242, a PCB formulation, was used as a model hydrophobic organic compound to determine the effect of various concentrations of organic solvents on the aqueous solubility of PCBs and the concentrations of organic solvents that affect the sorption of PBCs by earth materials. We have found that the solubility of Aroclor 1242 in polar solvents (ethanol, acetone, dioxane)/water mixtures was enhanced over its solubility in pure water. Moreover, these polar-organic, solvent/water mixtures dramatically decreased the sorption of PCBs by soil. The sorption coefficient (K_d) of Aroclor 1242 on Catlin soil from polar-organic solvent/water mixtures could be predicted from the change in solubility; empirical equations describing the effect of solvent concentration on sorption were developed.

These results are important to toxic, hydrophobic, organic-chemical waste-disposal. To increase the potential for migration of these chemicals from landfills, disposal of organic wastes and polar-organic solvents should not be made in the same landfill location.

Low-Level Radioactive Wastes

The Geological Survey has been frequently contacted by the Illinois Department of Nuclear Safety for advice regarding the geology, geochemistry, and hydrogeology of the Sheffield disposal site. The staff has acted in an advisory capacity to the Department of Health since 1964 when licensing procedures were established. The Department of Nuclear Safety is now responsible for the site.

Concurrently, the Survey is working on two major tasks with IDNS. In cooperation with IDNS, U.S. Geological Survey, Illinois Attorney General, and U.S. Ecology, Inc. (operator of the site), we are studying the movement of the main tritium plumes from the site. One major, fast moving plume and another slower moving plume have been identified. The Survey has also agreed to conduct geophysical surveys around the site to identify other possible contaminant pathways.

Also, the Survey is reviewing all existing hydrogeologic data at the site. IDNS must approve a decommissioning plan that ensures the site will not be a liability to the state in the future.

The Survey proposed to the Department of Nuclear Safety a hydrogeologic study to assist them in locating a new low-level radioactive waste-disposal facility. Federal law requires the state to be responsible for all low-level waste by 1986; the states may act individually or in compacts. Illinois may need a new site in the near future, and it is the responsibility of IDNS to locate that site. IDNS has proposed the initial stages of the project in the FY 85 budget.

Trench Covers

Study of Trench Covers to Minimize Infiltration at Waste-Disposal Sites (Cartwright, Johnson, Herzog, Larson, Morse, DuMontelle, and Stohr). This generic study, funded by the U.S. Nuclear Regulatory Commission through the University of Illinois, was initiated in October 1980 because of concerns related to leakage of low-level radioactive wastes at the Sheffield disposal site (Fig. 8).

It was hoped that radionuclide migration from low-level waste-disposal sites could be reduced by minimizing water contact with the wastes and that properly designed, constructed, and maintained trench covers could reduce such contact by limiting the infiltration of precipitation.

Several designs for layered-soil covers for disposal sites were developed on the basis of laboratory tests of locally available geologic materials and mathematical modeling of moisture movement through a variety of earth materials. Construction of four field-scale experimental covers for trenches was completed in July 1983. The Survey is monitoring the effectiveness of the experimental covers in limiting infiltration as well as the stability (an engineering factor) of the covers. Funds have been obtained for 2 more years to continue the monitoring.

Soil Testing of Trench-Cover Materials (Stohr). The discovery that two polluted monitoring wells at Wilsonville are in proximity to depressions (sinkholes) in the trench covers led to soil testing of materials in the covers. Through pinhole tests, soils in which the sinkholes developed were found to be highly susceptible to subsurface erosion (piping); whereas soils from nearby trench covers without depressions were not so susceptible to erosion.

Figure 8. Geologists collecting samples of native soil for analysis in a trench-cover study for the Sheffield waste-disposal site: Beverly L. Herzog, Hydrogeology Section, and Christopher J. Stohr, Earth Hazards and Engineering Geology Section.

Apparently, trench covers that erode easily can subsequently cause depressions or holes in the surface of the cover and allow surface water to flow directly into the trench.

Clay Mineral Orientation in Compacted Soils (Stohr). Knowing the orientation of clay mineral particles in compacted soils used in the construction of trench covers is important to understanding how water moves through them.

As a part of the engineering-geology investigation at Wilsonville, several methods of preparing samples have been studied. Some methods such as epoxy impregnation can not be used due to the low permeability of the soil samples. A successful method uses a special hot-thin wax solution that exchanges the soil water with wax without significantly changing the soil structure or volume of the sample. When cooled, the wax hardens and allows detailed examination of the particle structure.

Waste Management: Reclamation of Minewastes (Bradford, Berggren, DuMontelle, and staff). During 1982 and 1983, the ISGS undertook a major study, funded in part by the AMLRC, to evaluate the uses and reclamation of materials in the Historic Longwall District of north-central Illinois.

Communities in north-central Illinois experience problems with large piles of colliery waste in or near their homes. The piles resulted from a method of underground coal mining that involved hauling shale and clay overlying and underlying the coal to the ground surface, then disposing of the materials in piles. The larger piles are steep and mostly unvegetated. Sediments erode from them and fill ditches, causing localized flooding, or settle on farmland, where accumulations can make the land too clayey to plow.

The Abandoned Mined Lands Reclamation Council funded and published a study by the Illinois State Geological Survey to determine uses and reclamation of the materials. The report includes chemical and geochemical compositions and evaluations for toxicity and corrosivity; considers using the materials in industry or for secondary recovery of coal; and provides engineering properties of the waste, including an evaluation of angles at which the slopes would be stable.

Engineering firms are using our report as a basis for site-specific studies for reclaiming or otherwise using individual sites. One firm is currently planning the reclamation of a site at Dalzell, Illinois, with funds from the Reclamation Council.

Service Activities and Related Projects

Sludge Application in Rockton Township, Winnebago County, Illinois (Berg and Johnson). This study funded by the Rockton Township Board of Supervisors evaluates the potential that application of sewage sludge on agricultural land has for contamination of underlying sediments and groundwater resources: 16 monitoring wells and 2 lysimeter nests were set up in areas of repeated sludge applications. Water quality was sampled in September-October and again in March. Preliminary analyses indicate higher than normal percentages of nitrates.

Sampling will proceed for 1 more year, followed by analyses of organic chemicals and metals. This study will be published in the Survey's Environmental Geology Notes Series.

The Reuse of Water Through Artificial Recharge in Northeastern Illinois (Cartwright, Larson, and Dixon). The Geological Survey joined the Institute for Environmental Studies (University of Illinois), the Water Resources Commission, the Illinois State Water Survey, and the Metropolitan Sanitary District of Greater Chicago in a study to use treated sewage effluent for groundwater recharge. The objective is to provide a final stage treatment of sewage effluent resulting in a product acceptable for reuse. The study, partially supported by the Office of Water Research and Technology of the U.S. Department of the Interior, was initiated by the other agencies; funding was obtained prior to any detailed investigation of potential recharge. The Geological Survey was called into the project to locate and evaluate an aquifer for recharge. A site south of Aurora on land owned by Caterpiller Tractor Company has been tested and shown to be suitable for use in the experiment. A final report is now in press.

Hydrogeology of Waste Disposal: Reports and Activities

Reports are prepared upon request for the Illinois Environmental Protection Agency and local health agencies to aid in processing applications for operation of disposal facilities. These reports require a compilation of all available surface and subsurface geologic information as well as a field survey of the sites by one of the Geological Survey's professional staff. During the reporting period, 40 reports and related letters were written. About 3 times this number of questions (175) were handled directly through telephone calls or through discussions with visitors, consultants, and IEPA. The latter frequently required in-depth reviews.

Survey personnel also advise the IEPA concerning aspects of disposal into deep-saline aquifers. Both the Geological and State Water Surveys review applications for deep-disposal operations. Also, the two surveys, together with IEPA, dealt with 48 different deep-disposal problems, including 6 site visits. There continues to be high interest in deep-disposal wells, particularly since regulations are more stringent for disposal of liquid wastes in the surface and near-surface environments. Geological Survey staff have continued to participate in meetings with other state agencies to review federal regulations proposed by the U.S. Environmental Protection Agency under the Safe Drinking Water Act of 1974 (Public Law 93-5223). This activity has culminated in Illinois receiving primacy for the Underground Injection Control (UIC) in 1984.

GEOLOGIC STUDIES OF ILLINOIS LAKES AND RIVERS

The Geological Survey has conducted research in Lake Michigan since 1970. More than 800 grab samples, 300 bottom cores, and 2,000 miles of geophysical profiles have been collected on nearly 12 major lake cruises. More than 30,000 chemical analyses have been completed on these data; and 16 publications about the environmental chemistry of sediments, stratigraphy of lake sediments, and distribution of glacial till in the lake have resulted.

During the same period the Survey studied the Illinois shore to provide government agencies and the public with information on shore stabilities, shoreline erosion rates (expressed as shore recession probabilitities), lake level trends, and shore structures that might be at risk. The research has proved successful. On the basis of these studies, the Survey projected recession rates that are several times greater than those traditionally used.

These projected rates were supported by a study at Illinois Beach State Park. Because of winter storms in 1982-83, rising lake levels, and unusually severe wavestorms in 1983-84, the Park headquarters, the ranger storage buildng, the main bathing beach, and the service corridor (which contains the main water and sanitary lines of the park) developed high risk conditions (Fig. 9) Survey geologists determined that these areas were in danger of destruction within 1 year. Conferences, reports, maps, and field examinations with representatives of the Department of Conservation, the Illinois Division of Water Resources, the chief of the Chicago District Corps of Engineers, and coastal specialists from Corps regional headquarters contributed to the acceptance of the Survey's recession rates and risk evaluations.

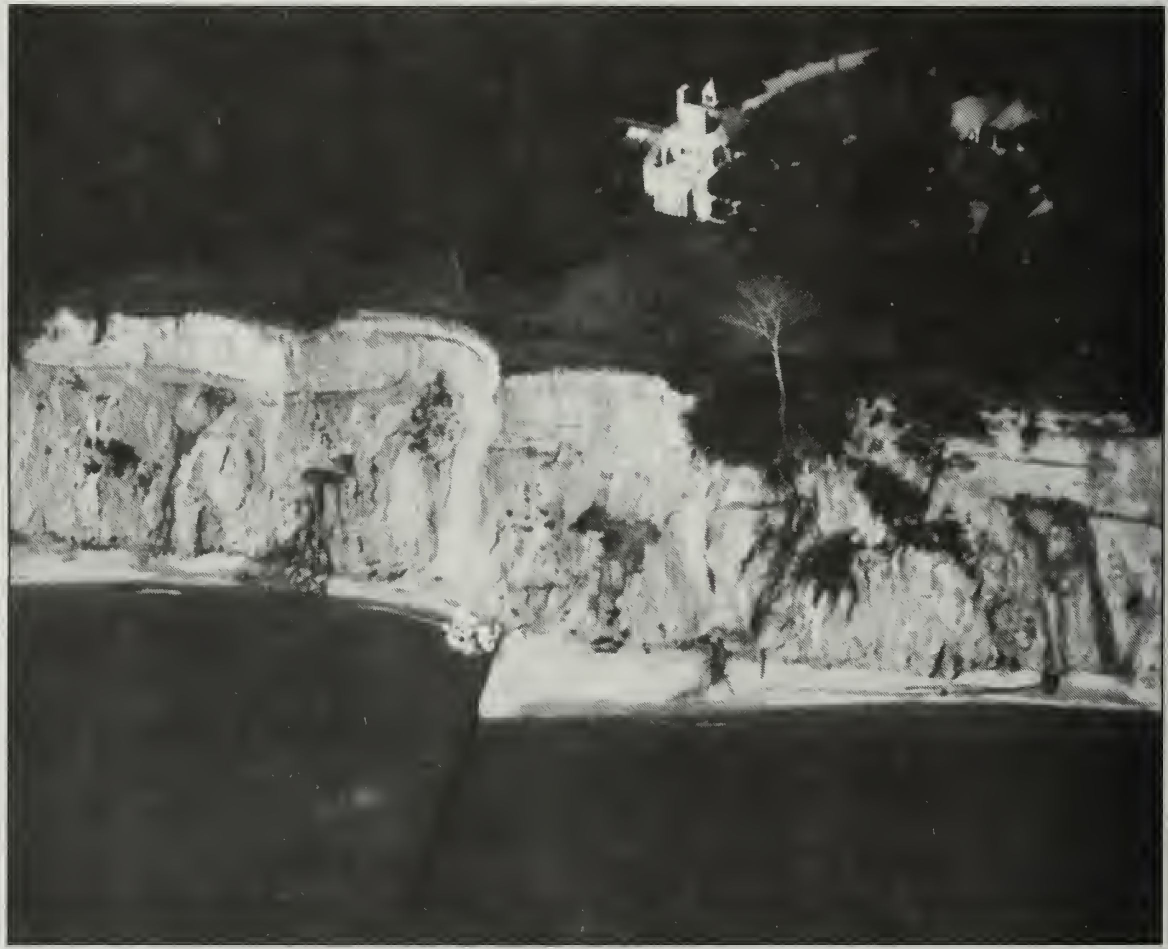


Figure 9. High-water levels returned to Lake Michigan in 1983, reducing beaches and accelerating bluff erosion. By the summer 1984, very high lake levels may again be part of the scene.

That acceptance last year made possible the application of special Congressional funds for improving the severe situation in Illinois. Congress has authorized a general shore protection feasibility study of the state-owned portion of the shore. This is the first phase of projected shore protection constructions. For the study, the Survey is providing current shore recession rates, photographic verifications, loss volumes for the past 50 years, and projected loss rates for the next 100 years.

The most important result of these efforts is the reversal of the policy excluding Illinois shore lands from federal funding. For the first time, federal funds are available for Illinois shore protection construction.

Unfortunately, the Survey has received only modest financial support because funds for Great Lakes research have, in general, diminished throughout the region. Nevertheless, plans are being developed with our sister scientific Surveys to begin Lake studies that center on lake processes, distribution of toxic sediments, and general evaluation of future research directions.

Recently developed studies on other lakes in Illinois focus on research in sedimentology, fate of pollutants, modeling of biological systems, and problems of water supply. Most Illinois lakes are filling with sediment at rates of 1/2 to 1 percent per year. Because many large water-supply reservoirs and navigation pools on the major rivers were built more than 40 years ago, sediment accumulation is now a problem. Basic research is needed to determine sources, movement, and deposition of the sediment as well as the biological effects of sedimentation, the chemical processes of sediment-pollutant interactions, and the fate of chemical pollutants.

The Long-Term Ecological Research (LTER) project on the Mississippi and Illinois Rivers, supported by a 5-year grant from the National Science Foundation, has been providing basic research on these ecological issues. Sediment erosion and deposition processes have been modeled, literature and agency responsibilities have been reviewed for a project funded by the Board of Natural Resources and Conservation.

Low-Level Aerial Photography Program for the Illinois Lake Michigan Shore (Collinson, Norby, and Sargent). Since 1972, the Geological Survey has maintained a program of periodic, low-level, oblique aerial photography that records detailed information about the entire Illinois shore north of Chicago. These photographs supplement the annual high-altitude photos provided by the Illinois Department of Transportation and constitute a unique record of shore changes and phenomena. The file now contains more than 18,000 color slides. More than 1,000 slides have been duplicated for use by other agencies; slides are frequently loaned.

Historical Shoreline and Beach Changes Between the Illinois-Wisconsin Statelines and Waukegan Harbor (Norby). A 9-mile reach of shore has been analyzed in detail to determine the amount of shore recession or accretion that has occurred over selected intervals of time since 1876. Annual measurements taken for the past 16 years indicate an increasing erosional rate related partly to higher lake levels and partly to a decreasing sediment supply entering this reach from Wisconsin: a projection of present erosional rates into the future may be too conservative. This long-range study will be continued until planned structures are in place and estimates of their effects can be make. Completion is planned for 1986 or 1987.

Site Studies for 1,000-foot Revetment at Illinois Beach State Park (Collinson, Norby, and Sargent). In the fall 1982, Collinson identified a 1,000-foot reach of shore at Illinois Beach State Park where buildings and basic service facilities were threatened with severe shore erosion. Because of the mild winter of 1982, the shore was under wave attack throughout the winter months and the situation deteriorated rapidly. Conferences on the subject were held in January and February. In March, the Corps of Engineers requested an up-to-date topographic map to calculate shore losses for the winter and to estimate spring and summer loss volumes. By May, a revetment had been designed and bids for construction requested. Shortly afterward, however, new shore losses required remapping the topography for revised site drawings. The Survey responded in 2 weeks. The contract for the revetment was awarded in December 1983; construction begins in April 1984. The Survey will monitor the stability of the completed structure.

Offshore Breakwater Feasibility Study: Lake County, Illinois (Collinson). The Chicago District Corps of Engineers has proposed a feasibility study for the construction of offshore breakwaters along 7 miles of shore in Lake County, Illinois. A favorable cost-benefit ratio based on land-loss figures provided by the ISGS makes the project possible. The Corps has requested shoreline recession rates back to 1935 as well as loss volumes, flooding predictions, and historical photos covering the past 50 years. Most data are already in ISGS files. The Corps has prepared a $2,000, 2-month contract with the Survey to hire an assistant to draft shorelines and complete volume computations. Completion date is June 1, 1984.

Illinois Division of Water Resources--ISGS Cooperative Monitoring Program for Low-Cost Shore Protective Devices in Lake Michigan (Collinson). At the request of the Illinois Division of Water Resources, Dr. Collinson participated in the surface and underwater examination of 12 installations on the Illinois shore. Underwater investigations were conducted at installations in Winthrop Harbor, Lake Bluff, Lake Forest, Wilmette, and Chicago.

In addition, the Director of the Illinois Department of Conservation asked Dr. Collinson to evaluate performance of a shore protection device that is being sold to government agencies. Such devices are now being marketed by six companies for the 60 miles of Illinois shore. Permits for installation of some devices have been withdrawn by IDWR as a result of the ISGS field examinations. Further surveillance has been requested for the summer of 1984.

Shoreline Processes and Geomorphology of Southwestern Lake Michigan (Collinson, Hansel, and Norby). This report was published as part of the field guide program for the 1083 Geological Society of America Conference. The report and special materials developed for the program are resources for future field trips in the Chicago area.

Mapping of Silurian Reef in Lake Michigan for Fisheries Studies (Collinson, Norby, and Sargent). In July, Julian's Reef in Lake Michigan was hydrographically mapped for the first time. Designated a commercial fishing preserve by the Illinois Department of Conservation, the reef consists of fossil Silurian bedrock. Located 18 miles southeast of Waukegan Harbor, the reef projects 100 feet above the lake floor and is approximately 1 square mile in area. It was the last habitat of naturally breeding lake trout before trout disappeared from the lake. More than 300,000 lake trout fingerlings have been artifically stocked there in recent years.

The initial hydrographic mapping was prepared for 1984 geological mapping of the lake floor and for study of the invertebrate and plant food chain. Periodic fish counts will be made in a cooperative study with the Natural History Survey.

Rivers and Back-Water Lake Research

Geological Mapping of Bottom Sediment in Pool 19 (Keokuk) of the Mississippi River (Casavant and Gross). To model the flow of organic carbon in a very large system, it was necessary to map the sediments in Pool 19. The trapping of carbon in recently deposited sediment may be an important component of the model. A set of maps was completed following extensive field sampling in 1982 and 1983. Although the pool is 70 years old, it is still accumulating sediment in the lower two-thirds of its 45-mile length. Sedimentation rates of 1 to 14 cm per year have been documented. There is a pronounced downstream fining of sediment grain size.

Comparisons of Pools and Prediction of Sedimentation in the Mississippi River (Gross). Pool 19 of the Mississippi River is accumulating sediment, but the equally old Pool 26 is not. This variation makes the prediction of sedimentation rates difficult unless further research can provide answers concerning this difference. Bottom sediment in Pool 19 has distinct downstream fining; sediment in Pool 26 does not. In the summer 1984, a reconnaissance of Pools 20 through 25 will be undertaken to determine whether downstream fining in a pool is the exception or the norm. Geologists will sample bottom sediment, biological parameters, and a slug of water as it flows 150 miles downstream. This intensive sampling expedition is scheduled for June and is a joint effort of ISGS, INHS, and Western Illinois University.

Geologic Mapping of Sediment in Pool 26 of the Mississippi River (Gross, Goodwin, and others). In the summer 1983, the 26-foot research vessel OMI was outfitted with a Mini-ranger navigation system to collect sediment samples and bathymetric profiles on an extremely accurate geographic base. Baseline measurements were made in the areas between the old and the new dams at Alton so that in several years we can return to study changes induced by the completion of the new lock and dam in 1985. Selected areas upstream of the dam were similarly surveyed in 1983 to allow comparisons with the 1980 mapping of Goodwin and Masters.

Carbon Analyses of Sediment for Modeling (Cahill and Autrey). Coulometric carbon analysis equipment was purchased with the LTER and ISGS funding and is now in successful operation. Sediment samples from the Illinois and Mississippi Rivers and plant samples from the INHS portion of LTER have been analysed. For analysis of carbon in sediments, the coulometric method is a significant improvement over previous methods of carbon analysis (Fig. 10).

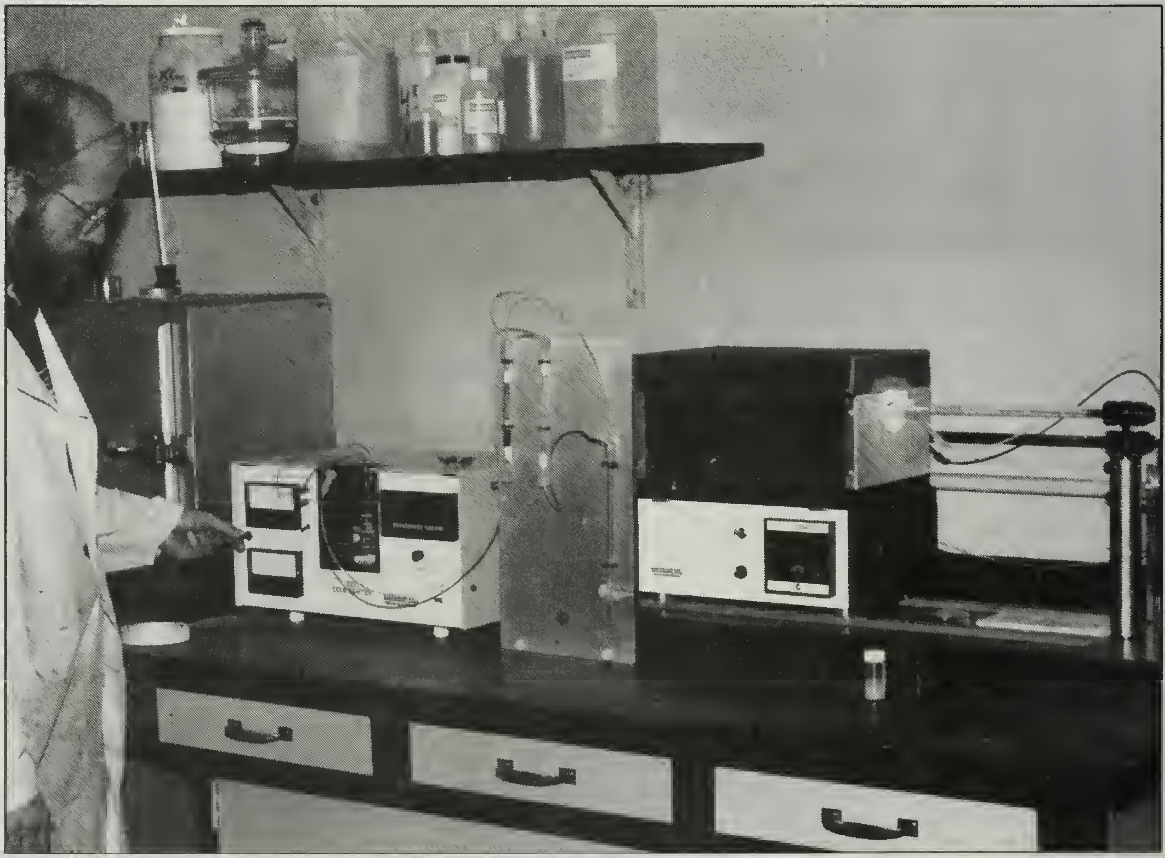


Figure 10. The total carbon analyzer shown here is especially useful in pollution studies where organic compounds adsorbed on sediments or in suspension (e.g., in bottom sediments of rivers and lakes) are a concern. Current plans also include use of the instrument to determine total carbon in petroleum source rock evaluations.

Sediment Geochemistry of Backwater Lakes Associated with the Illinois River (Cahill, Steele, and Gross). Chemical analyses have been completed on sediment samples from all three LTER study areas. Pools 19 and 26 of the Mississippi River are similar in their chemistry and relatively free of pollutants. In contrast, the backwater lakes on the Illinois River are highly polluted and provide a large-scale research laboratory for study of the movement of pollutants and the fate of heavy metals. Two hundred miles upstream in Lakes DePue and Brandon Roads, the sediment is highly polluted and toxic to aquatic life. A manuscript has been completed and is being reviewed for publication in the Environmental Geology Notes series of the ISGS.

Radiometric Dating of Sediment Accumulations (Cahill and Autrey). LTER funding has been used to initiate radiometric dating (cesium-137 and lead-210) of sediment accumulation. Cesium-137 results from the atmospheric testing of nuclear bombs and provides time markers for the last 25 years. Lead-210 has a half-life of 22 years, occurs naturally, and provides a time scale for about 100 years. Cesium work has been completed for six locations, providing the sedimentation rates used in LTER calculations. Progress with lead-210 dating has been slow because of complex radiochemical separation procedures, difficulties with new counting equipment, and low natural radioactivity in the samples. Nevertheless, the techniques do hold promise for dating events in our major rivers during the time of human activities.

Erosion

A Conceptual Model of Erosion and Sedimentation Processes in Illinos (Gross and Black; Bhowmik, ISWS; and Risser, INHS). Soil erosion and sedimentation are natural processes, but human activities have drastically increased the rate of both. To determine data gaps and research needs, to understand agency missions, and to provide a sound scientific framework for the design of programs, the Board of Natural Resources and Conservation funded a project involving all three Surveys. Eleven erosional models were developed, a 600-reference annotated bibliography was compiled, a survey of agency programs was completed, and a workshop was held for state and federal agency staff. Final editing of a report is underway.

HYDROGEOLOGY INVESTIGATIONS

Almost 50 percent of the people in Illinois and more than 95 percent of the nonurban population use groundwater as the source of domestic water. The Survey, in cooperation with the State Water Survey, assists residents and industry in locating and developing groundwater supplies. An accompanying research program provides the basic information needed to expand our knowledge of groundwater in the state.

Groundwater Geology

Geology and Hydrogeology of the Teays-Mahomet Bedrock Valley System (Kempton; W. N. Melhorn, Purdue University). The Mahomet Bedrock Valley of Illinois has been considered the lower reaches of a major bedrock valley system covering a large portion of the eastern midwest, heading in West Virginia, and crossing Ohio, Indiana, and Illinois. East of Illinois it has been called the Teays Valley. In addition to having a significant geologic history (development of the bedrock surface and stratigraphy of the glacial deposits filling the valley), it contains significant sand and gravel aquifers in some areas.

Kempton and Melhorn updated knowledge gained concerning the system at a symposium for the annual GSA meeting in Indianapolis. The ISGS took the initiative in preparing three papers for the symposium, compiling available information plus some new data on the Mahomet Valley in Illinois.

A Hydrogeological and Geophysical Investigation of Groundwater Resources in Kane County (Gilkeson and Heigold). In cooperation with the State Water Survey, a program was initiated in September 1983 to evaluate groundwater resources in the glacial drift (sand and gravel aquifers) and the shallow dolomite bedrock of Kane County. The county is providing funds to support the program, which is aimed at the management and protection of groundwater resources. At the present, deep sandstone aquifers in the Cambrian and Ordovician bedrock are the major source of groundwater for communities in Kane County. There is also a need for evaluating other water resources in the region because of declining water levels in the deep wells and concerns for water quality: high concentrations of radium and barium occur naturally in groundwater from the Cambrian and Ordovician bedrock over a major part of the county (see "Groundwater Geochemistry").

Survey hydrogeologists will use electrical earth resistivity, seismic refraction, and seismic reflection--state-of-the-art techniques--to explore for sand and gravel aquifers in the glacial drift and highly fractured zones of the shallow dolomite bedrock. The geophysical data will be correlated with the Survey's large inventory of geologic data from surface mapping, well records, and stratigraphic test holes to compile maps showing the distribution of aquifers in the county to a depth of approximately 400 feet.

Hydrogeologic Environments Along the Fox River Valley in Kane County (Gilkeson). In January 1984, a cooperative program with the State Water Survey was initiated to study the interaction between shallow groundwater flow systems and the Fox River in Kane and to provide information essential for the management of these water resources.

Survey hydrogeologists will use surface geophysical methods (electrical earth resistivity and seismic) to map geologic materials in the Fox River Valley. One innovation will be continuous seismic reflection profiles taken along the Fox River by instruments mounted in a boat. The geophysical program in the river valley will be integrated with the available geologic information to define regions where (1) shallow sand and gravel aquifers are present with open hydraulic connection to the Fox River, (2) shallow sand and gravel aquifers are present but separated from the river by thick deposits of clayey geologic materials, and (3) shallow sand and gravel aquifers are absent. The Division of Water Resources of the Illinois Department of Transportation is providing funds for the study.

Water Resource Potential of Basal Pennsylvanian Sandstones, Southwestern Shelf, Illinois Basin (Poole). In this project, freshwater resources of basal Pennsylvanian sandstone in Perry, Jackson, and a portion of Randolph County will be identified and delineated. This portion of the state suffers periodic droughts and water supply shortages. Glacial deposits, a major source of water elsewhere in the state, are generally thin and low- to non-water-yielding. Sandstones in the upper portion of the bedrock may yield small to moderate water supplies, but over much of the area the water is too mineralized for use. Current major sources of public water supplies are surface reservoirs which are difficult to maintain over long periods of time. Many individuals not connected to a reservoir system rely on cisterns for their water supply.

The identification and delineation of this little-studied and generally unused source of freshwater will directly benefit people in this area of the state. The project will generate several maps illustrating the distribution and estimated quality of the water resources of the basal Pennysl vanian sandstones.

Drift Aquifers in Northeastern Illinois (Piskin and Dixon). This project is a part of continuing investigation of water resources of the region by the ISGS and conducted in cooperation with Northeastern Illinois Planning Commission. Sand and gravel aquifers in the glacial drift contribute significantly to the available groundwater resources of the area. Maps of the aquifers and a text describing character of the aquifers have been completed. The text is now undergoing revision and will be completed by June 1984.

Hydrogeology of the Mississippi River Valley in West-Central Illinois (Piskin). Investigation of the groundwater potential of Mississippi River Valley deposits on the Illinois side of the river from Rock Island into Calhoun Counties will be completed at the end of 1984. The study includes evaluation of thickness and character of the valley fill and delineation of the bedrock surface. The report will assist people who are interested in the physical character of the valley fill and its groundwater conditions.

Midwest Regional Aquifer Assessment (Cartwright). In cooperation with the State Water Survey and the U.S. Geological Survey, we are studying the Cambrian and Ordovician aquifers in the northern third of Illinois. The study covers the Illinois portion of the six-state regional aquifer assessment being conducted by the USGS. The aquifers are important sources of water for the major cities of the region, including Chicago and Rockford. Using existing stratigraphic information, maps of the aquifers of the Cambrian and Ordovician Systems in northern Illinois were updated. We also assisted in developing transmissivity maps. The USGS drilled a deep test well near the Illinois-Wisconsin stateline that encountered the granite basement at 3,420 feet. During the drilling, water sampling and aquifer tests were conducted by packing individual zones. Several piezometers were installed for long-term monitoring. A draft report has been completed and revisions are underway.

Groundwater Geochemistry

Hydrogeologic and Geochemical Studies of Selected Natural Radioisotopes and Barium in Groundwater in Illinois (Gilkeson and Cartwright). Dissolved concentrations of stable isotopes, radioisotopes, and major ions were investigated in groundwater from the major regional aquifer of northern Illinois--the Cambrian and Ordovician bedrock. The study was supported in part by funds provided by the U.S. Department of the Interior. Significant findings have been presented in two reports in the ISGS Contract/Grant Series.

The research established that high dissolved radium and barium concentrations are naturally present in the major aquifers--the sandstone bedrock. Dissolved barium concentrations in excess of the drinking water regulation of 1.0 mg/L occur in a several-county region of northeastern Illinois and in restricted localities of northwestern Illinois. The combined concentrations of radium-226 and radium-228 ranged from 2.3 to 50.2 pCi/L; most analyses exceed the drinking water regulation of 5.0 pCi/L. Geochemical mechanisms that control the concentrations of the natural contaminants in groundwater are discussed in the report.

Studies with stable isotopes established that high barium concentrations are due to microbially mediated reactions occurring in anaerobic environments of the bedrock. Unexpectedly, groundwater from the Cambrian and Ordovician bedrock was extremely enriched in dissolved uranium-234 over a large region of northeastern Illinois. Researchers at Argonne National Laboratory are using this unique, enriched groundwater as a natural tracer to investigate how the human body metabolizes uranium.

Statewide Groundwater Quality Monitoring (Gilkeson and Brower). An interagency program was initiated in December 1984 to establish a groundwater quality monitoring network for Illinois. Agencies involved in the program with the State Geological Survey are the State Water Survey, the Illinois Environmental Protection Agency, and the U.S. Geological Survey. The goals of the monitoring network are (1) to characterize the background chemical quality of groundwater from the aquifers of Illinois; (2) to investigate the variation in chemical quality that may occur naturally over time; and (3) to investigate changes in chemical quality that may be related to human activity. An evaluation of the impact of human activity on groundwater quality requires information on the background chemical composition of the groundwater.

The four agencies have designed the monitoring network, established sampling methods, and selected constituents for analysis as well as wells for sampling; 120 wells were selected for a trial sampling program to be conducted during the spring 1984. The Geological Survey will collect the groundwater samples from wells located in the southern region of Illinois.

Geophysical Support Efforts

Mapping Aquifer Transmissivity by Surface Electrical Methods (Heigold, Gilkeson, Reed, Cartwright, and Larson). The water-producing capabilities of shallow aquifers can be evaluated with surface electrical methods by utilizing the relations between bulk resistivity of the saturated sediments, the pore water resistivity, and the hydraulic conductivity of the aquifer. Over the years, the Geological Survey has compiled a statewide file of electrical surveys of shallow municipal aquifers. This file is being systematically reviewed and the data reevaluated to determine whether a general relation exists. It is anticipated that aquifers in differing geologic environments will show different relationships.

Supplemental Groundwater Supplies for Six Small Communities in Illinois (Poole and Vaiden). Electrical earth resistivity (EER) surveys aided in locating test drilling sites for new municipal wells in the vicinity of each of six water-short communities. After analyzing the EER data and reviewing geologic data for the area, we recommended future test drilling sites. This study is part of a long-term series of studies funded by the Division of Water Resources (IDOT) to assist small public water systems.

Service Activities

Groundwater Geology and Electrical Earth Resistivity Surveys (staff). Letter reports on groundwater geology are prepared to accompany reports by the State Wate Survey in response to requests by citizens for information. Many requests are for information to assist in locating new or additional water supplies. Electrical earth resistivity surveys frequently supplement the requests for geologic information.

A total of 547 letters, reports, and technical letters were prepared in 1983-1984. The statistics for groundwater reports are

Public water supplies	10
Farms and rural residences	108
Industrial and irrigation	22
Special studies	9
General technical information	398
	547

An increasing number of requests are now handled by telephone; the above list does not include requests handled through telephone conversations or for visitors who come to the Survey to obtain help on specific problems. A total of 797 requests for information were handled by telephone, and 103 visitors came to the office during this year.

Geophysical Logging of Wells (Reed and others). The new Log Master geophysical logger, funded by the Division of Water Resources, is used to run electrical and gamma-ray logs in uncased holes and gamma-ray logs in cased holes. A total of 18 service logs were run for special problems. Geophysical logs are particularly useful to identify strata, earth materials, and fluids penetrated by a well where no data were reported by the driller. Logs can be run to a maximum depth of 3,600 feet.

Other Studies and Projects

Illinois Irrigation Association Convention and Midwest Water Well Exposition (Cartwright, Reed, Brower, and Piskin). The Hydrogeology and Geophysics staff participated in the Midwest Water Well Exposition held by the Illinois Water Well Drillers' Association in Rockford in March 1984 (Fig. 11). A display demonstrated how the Boone and Winnebago County study was conducted, with emphasis on the problems of groundwater contamination. An irrigation map was also displayed. Survey programs were discussed with drillers and irrigators, and many questions relating to the development of groundwater supplies and geologic research in the state were answered.

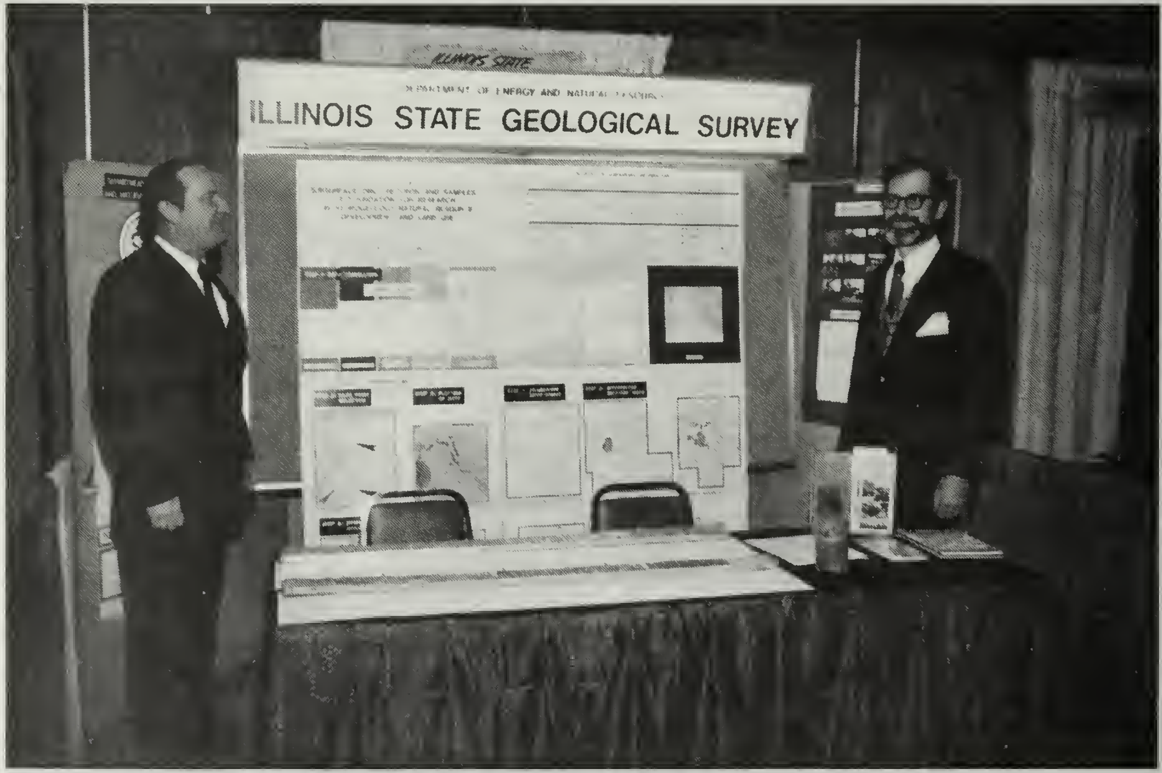

ILLINOIS STATE
DEPARTMENT OF ENERGY AND NATURAL RESOURCES
ILLINOIS STATE GEOLOGICAL SURVEY

Figure 11. 1983 Water Well Exposition in Decatur. Poster session: Philip C. Reed and Ross D. Brower, Hydrogeology Section.

EARTH HAZARDS AND ENGINEERING GEOLOGY

"Earth Hazards" was added to the name of the Engineering Geology Section to focus attention on one of the major tasks of the section. The program is supported by the state, by the U.S. Geological Survey, the Federal Emergency Management Administration, the Illinois Emergency Services Disaster Agency, and the Abandoned Mined Lands Reclamation Council. Research is conducted on both man-made and natural earth hazards. Man-made geologic hazards include subsidence of the surface due to mining operations, surface excavations, borrow pits, or improperly designed construction projects and waste-disposal operations. Natural geologic hazards include landslides, earthquakes, and shrinking/swelling soils caused by drying, then wetting as the weather changes. Information on these hazards is provided to the public, to industry, and to government agencies for planning and decision making. Remedial actions are suggested where appropriate.

Landslides

Inventory Map of Landslides in Illinois (Killey, Hines, and DuMontelle). During 1983, the ISGS received some suppport from a small USGS grant, completed an inventory of all known landslides and slumps in the state, and organized all available information on the slides into a standardized format. This project also focused on the general geologic conditions existing in landslide-prone areas of the state, thus identifying areas of high landslide potential. The study produced (1) a 1:500,000-scale maps of the state showing locations and types of landslides; (2) a bibliography listing all known publications referring to landslides in Illinois; (3) a table summarizing types of landslides; (4) a table listing landslides for which damage or repair costs have been reported; (5) computer-assisted data file listing all known information on the mapped landslides (to be updated periodically as additional slides are reported); and (6) a traveling poster display. A report of the study will be published by the ISGS, accompanied by the 1:500,000-scale inventory map published by the U.S. Geological Survey. Efforts will continue to maintain the inventory and to distribute information to the public.

Analysis of a Slump-type Landslide, Southwestern Illinois (Krumm). A landslide along the Mississippi River bluffs near Caseyville, St. Clair County, has been the focus of a detailed study. Ground movements have damaged one residence at the site; continued movements further upslope could damage another. Instruments were installed and monitored to determine the magnitude and direction of the movements. Also, samples were collected to characterize the geologic materials. Examination of the failure pattern and field measurements indicate movements characteristic of a rotational slope failure and not a mine subsidence event.

Earthquakes

Predictions by noted authorities have renewed popular interest in a possible repeat of the disastrous 1811-1812 New Madrid earthquakes. The

Illinois Emergency Services and Disaster Agency will soon issue a brochure prepared by Survey staff describing historical earthquakes and the potential for damaging earthquakes in Illinois. The agency has indicated strong interest in planning a series of regional workshops throughout the state emphasizing earthquake preparedness for medical institutions, utility companies, news media, and others directly responsible for the public welfare in emergency and disaster situations. The ISGS has agreed to contribute to these workshops through presentations and handout materials.

Subsidence of Land Surface

Over 750,000 acres of Illinois have been undermined for coal. Residents in 34 counties have filed claims for damage caused by mine subsidence. Although less than 20 percent of the damage listed in the claims is determined to be for subsidence, the damage is substantial. Subsidence in both agricultural and urban areas is a problem; the expansion of towns over mined-out areas has resulted in subsidence affecting more structures.

Current research incorporates better methods and new tools for understanding the failure of a mine, the propogation of the failure through the ground to the surface, the surface expression of subsidence, and its effects on houses and other structures.

Current projects involve both active and abandoned mines--accumulating data from site investigations of new subsidence events. Mapping delineates densities of subsidence events based on insurance claims. Profile, strain, and time characteristics of subsidence events are under investigation. The use of aerial photographs to identify subsidence features is being evaluated.

Economic Effect of Coal Mine Subsidence on Agricultural Land in Illinois (Hines and Bauer). This study is the first small-scale investigation of the impact of subsidence on agricultural land. Supported by the Illinois Department of Energy and Natural Resources, the contract is with the Agricultural Economics Department of the University of Illinois; we are a subcontractor.

An inventory of mined-out acreages by county and mine plan was completed for the entire state. Currently, air photos of areas in 8 counties that contain underground mines are being used to determine how many surface depressions are natural and how many may be related to mine subsidence.

Field Investigations of Mine Subsidence (Bauer). Ten alleged subsidence sites were investigated in response to requests by the subsidence response team of the Abandoned Mined Lands Reclamation Council, by the Mine Subsidence Reimbursement, and by private citizens. Also, ten subsidence events were measured on five farms in Macoupin, Christian, Sangamon, Randolph, and Vermilion Counties in connection with a study supported by the Twin City Research Center of the U.S. Bureau of Mines. They were added to the case history file.

Establishing a Computer-Assisted Directory of Mine Subsidence Insurance Claims (Bradford, Bauer, DuMontelle, Evans, and Cooper). More than 1,200 insurance claims have been filed for mine subsidence since the Mine Subsidence Insurance Program was established in October 1979: 80 to 90 percent of the structures have been damaged by phenomena other than mine subsidence. A computer-assisted directory of claims, funded by the Illinois Mine Subsidence Insurance Fund, has been established. Information in the directory is divided into three files: general information in the claims, specific information in the claims, and information on coal mines. This information will aid the insurance industry in reviewing nearby and possibly related claims, and also allow for efficient sorting and retrieving capabilities. Information in the directory will show clustered areas of problematic soils as well as other natural or man-made hazards, linking damage to categories of causes. Using the directory, the Geological Survey will respond rapidly to requests for subsidence information for insurance claims.

Surveys to Detect Movement of the Surface Caused by Subsidence (DuMontelle and others). Mine subsidence may have caused cracking of the ground and subsequent leakage at the Wilsonville waste-disposal site. A series of monuments were established and regularly surveyed, using precision surveying techniques.

The computer programming efforts to analyse and present the Survey information from the Wilsonville project were grouped into three phases: (1) a thorough analysis of the existing computer program written by Wen-June Su; (2) a study of the tiltmeter documentation essential for analysis for the tiltmeter readings; and (3) the design and implementation of a modular data entry and processing system to plot graphically the incremental, cumulative, and net changes for both strike and dip of each tiltmeter plate.

Perodic surveying of monuments at the hazardous waste site shows that the vertical movement of the monuments and probes is more complex than expected. Vertical movements occur within the range of 1/2 to 3 mm. The survey accuracy is probably between 1 and 2 mm, although closure errors are routinely less than that. Monuments show some cyclic or seasonal movements, but these are not always consistent. Results will be interpreted after additional surveying.

Soil Hazards

According to the U.S. Geological Survey, common soil problems are many times more costly to property owners than are problems caused by other geological hazards. Illinois soils that are susceptible to shrinking/swelling and to erosion have substantially damaged houses and other structures. The magnitude of the problem is indicated by our review of more than 1,200 insurance claims filed for mine subsidence: more than 80 percent of the damage claimed is for soil problems.

The ISGS has monitored and studied damaged structures in Illinois. Some soils swell and shrink as they wet and dry, or freeze and thaw.

During droughts, soil falls between cracks in the ground, particularly where it has pulled away from foundations. This increases the density of the soil. Upon wetting and swelling, soils may exert enough pressure on a house so that the foundation cracks--requiring the structure to be supported with braces or jacks. Similarly, when the water in soils freezes, swelling occurs. Also, water freezing in broken structures can add to the cracking.

Miscellaneous

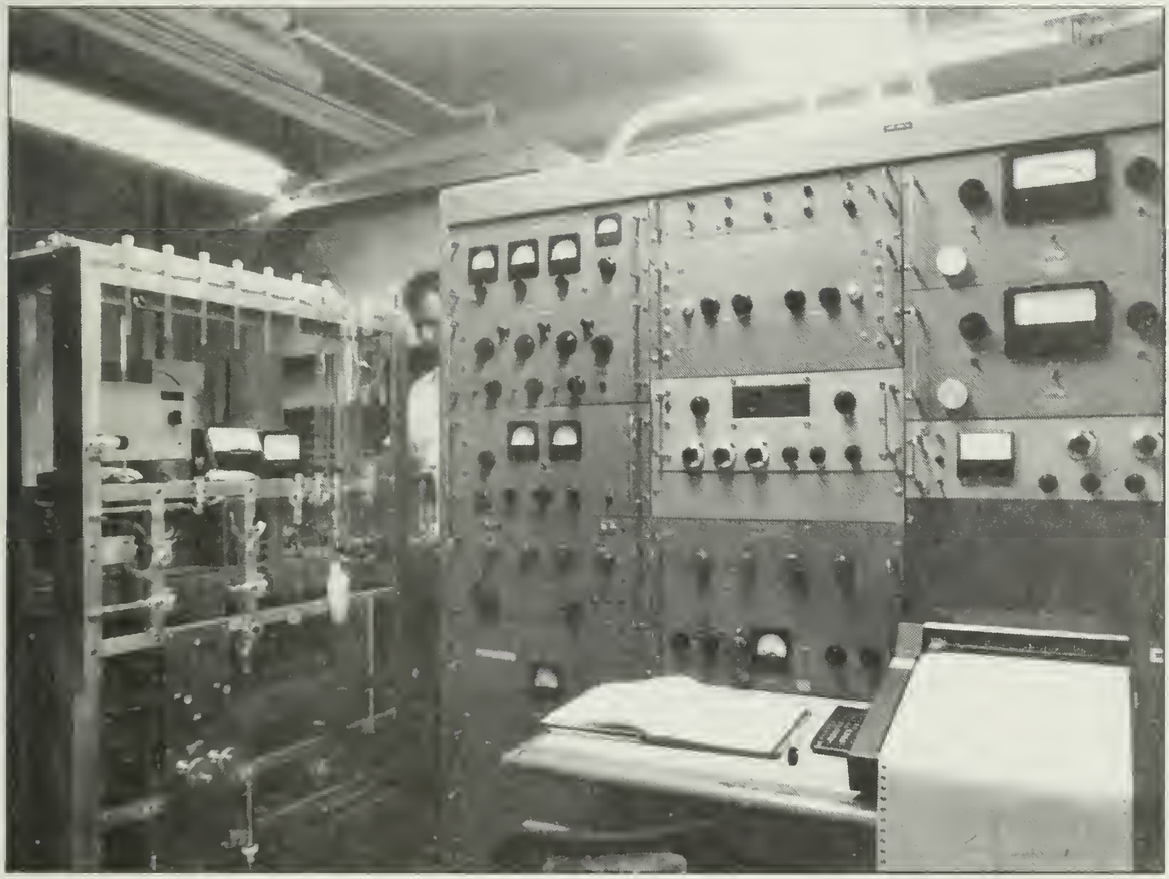
Characterizing Man-Made Material for MX Missile Project (Bauer). The Civil Engineering Department at the University of Illinois, Urbana-Champaign, is using concrete to simulate joined rock. The simulated rock will be loaded and a tunnel built in the rock; movements of the tunnel walls will be monitored. The Survey has a specific strength testing device that is being used to fully characterize the strength of the rock-like material for the project.

Inter-Survey Geotechnical Laboratory Organization and Operation

Effective March 1, 1984, the Inter-Survey Geotechnical Laboratory was formed by combining the staff and equipment of the Water Survey Sediment Laboratory with the present Geological Survey Particle-Size Laboratory. The ISWS staff and equipment formerly housed at 501 South Wright were transferred to the Natural Resources Studies Annex where additional space was provided.

The state-related research and service analyses, which were being conducted separately for the Geological Survey, Natural History Survey, and the Water Survey, were combined for operational efficiency and staffing back-up. The Geotechnical Laboratory is administered through the offices of the State Geological Survey and the staff and equipment associated with the Laboratory are permanently assigned to that Division. The Laboratory is operated under the guidance of a three-member advisory committee consisting of one member from each of the three scientific Surveys.

GENERAL AND BASIC RESEARCH



Isotope ratio mass spectrometer. Dennis D. Coleman, Head of Analytical and Isotopic Chemistry Section.

GENERAL AND BASIC RESEARCH

GEOLOGIC MAPPING

Geologic mapping is fundamental to all economic and environmental programs at the Survey. Geologic data collected from field observations, test borings, sample analysis, and laboratory tests are compiled on a suitable map base and projected into a two-dimensional--sometimes three-dimensional--presentation of the earth's surface and subsurface.

The state's cartographic program, a cooperative effort of the ISGS, USGS, and other agencies, not only provides base maps for Survey studies, but also supplies cartographic information to a broad range of users. The jointly sponsored USGS, ISGS, and IDOT (Illinois Department of Transportation) topographic mapping program provides 1:24,000-scale 7.5-minute quadrangle maps covering the entire state. These maps are useful to planners, developers, builders, sportsmen, vacationers, and many others. The ISGS is also continuing to review satellite imagery, high altitude photography, and forms of remote sensing combined with digital modeling and other computer-assisted cartographic techniques.

Demands for programs oriented toward specific economic and environmental problems emphasize the need for a more active program of basic geologic mapping. For example, decisions to investigate for coal or oil are based on regional mapping of structural geology. Also criteria for selecting sites suitable for safe landfilling of hazardous wastes are only as valid as the current status of geologic mapping. At present, mapping projects include a few surficial (Quaternary) geology studies at the county scale and one surface-to-bedrock study at the quadrangle scale. With some outside support, basic geologic mapping could be better balanced with applied geology. For this purpose, the Survey is considering a cooperative geologic mapping program (COGEOMAP) offered by the USGS, patterned after their cartographic program.

Surficial Geology

Stack-Unit Map of Illinois (Berg and Kempton). This map--the first of its kind in the United States--is a basic geologic map of the upper 50 feet of Illinois. Preliminary mapping for this project was carried out for the IEPA to screen waste-disposal sites for the state. Detail was added to the geology by incorporating all information in the upper 50 feet. Subsequently, the map was digitized for the Lands Unsuitable for Mining Program (LUMP) by the Environmental Systems Research Institute in California. It is the base map for all preliminary geologic appraisals for the LUMP program.

Bedrock Surface of Illinois (Piskin). The previously published bedrock surface map of Illinois is being revised with added control. Contour lines on the map will show bedrock surface elevations in buried valleys and uplands. Buried valleys are important because of their groundwater potential. The map will also interest geologists, hydrogeologists, engineers, and others concerned with general appraisal of overburden on bedrock.

Research and Development: Three-Dimensional Geologic (Stack-Unit and Terrane) Mapping Techniques (Kempton, Berg, and Cartwright). The general acceptance and increasing use of three-dimensional maps (sequences of geological materials plotted both vertically and areally on one base map) for developing land-use and hydrogeologic interpretations as well as for geologic evaluations has stimulated work on developing new mapping techniques. The Prime 750 capabilities allow sophisticated techniques, particularly for stack-unit and terrane mapping.

At the annual meeting of AEG in San Diego--the Symposium on Engineering Geology Mapping--we presented an invited paper on the subject: Three-Dimensional Mapping, A Basic for Hydrogeologic and Land-Use Evaluations. The AEG Bulletin is publishing the paper.

Surficial Geology of Madison County (McKay, Killey, Hines, and Fox). A stack-unit map of the surficial geology of Madison County at a scale of 1:62,500 was compiled from 1:24,000-scale field maps. The topography of the bedrock surface was also mapped at the same scale. A report of the geology of Madison County, containing sections on the engineering, land-use, and resource implications of the county's geology, is 75 percent complete. These maps and the report conclude the long-term mapping effort in Madison County and the adjacent counties of the Metro-East region of southwestern Illinois.

Geologic Mapping: Champaign County (Killey and Kempton). Basic stratigraphic data has been gathered and interpreted. A preliminary stack-unit map for Champaign County has been completed to a depth of 20 feet. We plan to rework the map to a depth of 50 feet, then use it as a base for a complete geology-for-planning report.

Bedrock Mapping

Creal Springs Geologic Quadrangle (Trask and Jacobson). Detailed field mapping in the quadrangle has led to better definition and understanding of structure and coal resources in the lower part of the Pennsylvanian System. Coal resources identified for this area have substantially increased as a result of aeral mapping of a coal poorly known outside western Kentucky. Structure formerly thought to be a fold has been demonstrated to be a fault block similar to those in the Illinois-Kentucky Fluorspar District. A widespread limestone found during mapping will help to date these strata in relation to the Midcontinent and aid in determining environments of deposition of these poorly understood rocks. Papers were presented on the structure (AAPG, Carbondale) and on the limestone (GSA, Indianapolis) this past fall.

Topographic Mapping and Cartographic Information

The Survey has coordinated the cooperative topographic mapping program in Illinois with the U.S. Geological Survey since 1927. We continue to supply both maps and information through the Engineering Geology Section. Of the 1,072 (total) 7.5-minute quadrangles covering Illinois, 865 or nearly 81 percent have been mapped in the 1:24,000-scale series. Of the 7.5-minute quadrangles, 207 remain to be completed; work is in progress on 183; 24 quadrangles remain to be authorized. Now available are 6 topographic quadrangle maps in the new 1:100,000-scale series; work is in progress on 6 others. To complete coverage of Illinois in this series, 33 quadrangles remain to be authorized.

In 1975, the Illinois Mapping Advisory Committee (IMAC) was established to exchange information on mapping programs and techniques with state and federal agencies, planning commissions, industries (oil and gas, coal, and construction), and others. IMAC was responsible (1) for developing funding to accelerate the 7.5-minute topographic mapping program, which is now scheduled for completion in 1986; (2) for advising on the needs and future direction for acquisition of cartographic information from the USGS; and (3) for organizing the Illinois Affiliate Office of the National Cartographic Information Center (a combined responsibility of the ISGS and the University of Illinois' Map and Geography Library). The Survey, together with the Illinos NCIC office, provides the preparation, purchase, advertising, sales, and distribution of cartographic products.

In 1982-83, the University of Illinois Committee on Aerial Photography and Remote Sensing was revived. In the areas of photo interpretation and remote sensing as well as land-survey control data, explanation and calculation of coordinate systems, and other map applications, the ISGS offers expertise.

During this report period, the NCIC Affiliate received 240 telephone calls, 135 letters, and 150 visitors requesting geodetic and general cartographic information. The Survey received 84 new and photo-revised 7.5-minute quadrangle topographic maps. This office distributed 109 new maps in the Official Free Distribution Program.

GEOPHYSICAL INVESTIGATIONS

The Illinois State Geological Survey has been involved in all four main areas of geophysical research (seismic, electrical, magnetic, and gravity) as well as shallow geothermic surveying. Effort has also been expended in the field of earthquake seismology.

The Survey is a recognized leader in surficial electrical resistivity methods. Statewide gravity coverage is excellent. Also, the shallow geothermic method is developing into an operational exploration tool for groundwater supplies.

Aeromagnetic coverage of the state is not complete, however. There are gaps to be closed; existing coverage must be made uniform through analytical techniques. The Survey has no deep-seismic reflection data in its files. These data are essential if the Survey is to undertake meaningful studies on the state's remaining oil and gas potential.

Gravity-Magnetic Investigation

Possible Meteorite Impact Structure in Southeastern Macoupin County, Illinois: Implications for Hydrocarbon Accumulation (Howard, Heigold, Kolata, and Nelson). During the summer of 1983, a detailed gravity survey was performed over the Johnsonville Oil Field in Wayne County, Illinois, in an attempt to ascertain the origin of its geologic structure. The Johnsonville structure is just one of several geologic structures in Illinois that are suggestive of meteorite impact.

Ground Magnetic Surveying to Determining Trench Boundaries at Waste Disposal Sites (Heigold and Gilkeson). The exact location of trench boundaries at waste-disposal sites where contaminant migration has been observed is extremely useful information in calculating flow rates of contaminants. At many of the older sites, maps showing the location of trench boundaries are not available. Moreover, physically probing into and around the burial trenches is not desirable. Thus, surface geophysical techniques that can locate trench boundaries quickly without disturbing the environment of the disposal site are needed. One geophysical method, ground magnetic surveying, was found to be extremely effective where waste has been buried in ferruginous containers.

Structural Styles from Seismic Data

Acquisition and Interpretation of Deep Seismic Reflection Data (Schwalb, Howard, and Heigold). The ISGS does not at present possess deep seismic reflection data for the Illinois Basin. Such data are necessary for the structural geologist who proposes to accurately construct the framework of the Illinois Basin and examine the structural styles in detail. Both tasks are needed to stimulate ideas, reduce exploration risks, and encourage industry to explore for hydrocarbons in both new and deeper "plays" in the Illinois Basin. For accomplishing these tasks, drill hole data are useful, but not adequate. Deep seismic reflection data are expensive but essential. Means to acquire these data are being pursued.

Integrated Geophysical/Geological Mapping Investigations

Shallow Geothermic and Surficial Earth Resistivity Surveys at the Sheffield Low-Level Radioactive Waste Disposal Site, Bureau County, Illinois (Heigold, Gilkeson, and Larson). Shallow resistivity and geothermic exploration techniques have been successful in mapping a pathway for escaping pollutants in the shallow, unconsolidated deposits east of the waste disposal site. Similar surveys are being run in areas surrounding the site to locate other conduits through which pollutants may leave the site.

GEOCHEMICAL INVESTIGATIONS

Isotope Geochemistry

Radiocarbon Dating (Liu, Fisher, and Coleman). Last year, radiocarbon ages were determined for approximately 140 samples; an equal number of $^{13}C/^{12}C$ determinations were performed for isotopic fractionation corrections. Approximately 50 percent of the samples analyzed were paid for with funds from outside sources.

Stable Isotope Ratios as Naturally Occurring Tracers in the Aquaculture Food Web (Coleman and Morin; Buck, State Natural History Survey). This is a joint project with the Natural History Survey, funded by the United States-Israel Binational Agricultural Research Development Fund (BARD). In this research, natural isotope tracers are used to evaluate (1) the significance of the available foods in an aquaculture system, and (2) the effectiveness of certain agricultural wastes as fish foods.

Analytical Services Provided by the Chemical Group

	Number of samples	Number of determinations
Chemical Analyses		
Coal and related samples	456	3,400
Rock, sediment, and mineral samples	738	9,120
Natural gas analyses	61	793
Leachates and extracts	600	14,038
Isotope Determinations		
Radiocarbon age samples	140	140
Cesium-137 for sedimentation rate	7	90
Lead-210 for sedimentation rate	8	180
Stable isotopes	594	1,100
Others		
Internal surface area measurements	27	27
TOTALS	2,631	28,888

STRATIGRAPHIC INVESTIGATIONS

The Survey gathers information about the basic rock units that make up the geologic framework of the state. New emphasis is being placed on the stratigraphy of Cambro-Ordovician rocks and on the stratigraphy of Mississippian rocks, both of which produce petroleum. Also, the Cambro-Ordovician rocks are major sources of water supplies in the state. General studies of Silurian rocks have been revived. Extensive petroleum exploration and development have recently taken place in this sequence of rocks in west-central Illinois. A new study of Silurian microfossils from cores will aid subsurface correlation capability. In Quaternary stratigraphy, Dr. Ardith Hansel has renewed a study of glacial and Holocene deposits in the greater Chicago region.

Quaternary Stratigraphy

Revision of the Wedron Formation and Detailed Study of the Wedron Type Section (Hansel, Follmer, and Glass; W. H. Johnson, University of Illinois). In 1980, Quaternarists proposed raising the Woodfordian Wedron Formation to group status. Detailed study of the stratigraphy and genesis of deposits at the Wedron type section began in June 1983.

As an important reference standard for the north-central United States, this type Section was visited and studied by ISGS geologists several times during the year. Drs. Follmer and Hansel led parties of scientists from the United States and abroad who wished to study the section.

Stratigraphy of Lake Deposits Relative to Holocene History of the Lake Michigan Basin (Hansel and Glass). Data from 14 cores, collected during the 1978 R. V. LIMNOS cruise in northern Lake Michigan, are being analyzed and interpreted to unravel the history of lake outlets and land uplift.

Quaternary Stratigraphy in Northeastern Illinois (Hansel and Glass). Characterization and correlation of Quaternary deposits in northeastern Illinois continue through study of outcrop, water well, and engineering boring samples from this critical area. As samples are collected, clay analyses and radiometric analyses are made. This relatively long range study is supplying basic information for engineering, water supply, stratigraphy, and Holocene history projects.

Lake History in the Greater Chicago Area (Hansel and Collinson; Larsen, USGS). Detailed stratigraphic studies of deposits in the type area of glacial Lake Chicago (northeast Illinois to northwest Indiana) have been undertaken. In the past 24 months, the ISGS Isotope Geochemistry Lab has produed 35 radiocarbon dates from materials collected from shoreline deposits between Kenosha and Gary. The dates make it possible to reconstruct lake history for the past 12,000 years.

Quaternary Evolution of Lake Michigan--Late Wisconsinan and Holocene History of the Lake Michigan Basin (Hansel; Mickelson, University of Wisconsin-Madison; Schneider, University of Wisconsin-Parkside; and Larsen, USGS). The effects of Late Wisconsinan glacial events, post-glacial uplift, and Holocene climatic fluctuation in the Great Lakes region are being analyzed to reconstruct lake level history in the Lake Michigan Basin for the past 14,000 years.

Evidence for Stagnant Ice in the Chain O'Lake Lowland During Deposition of Haeger and Wadsworth Till (Hansel and Glass). This study examined surface and subsurface data relating outwash to till sources and ice events. A report has been prepared describing analytical techniques used to identify outwash sources.

Glaciation and Origin of the Geest in the Driftless Area of Northwestern Illinois (Willman, Glass, and Frye). Scattered upland gravels and boulders in the western part of the Driftless Area suggested that Nebraskan and Kansan glaciers might have covered much of the area. This study examined the sands, pebbles, and clays of alluvial deposits in the area. We investigated in detail the clay ("geest") that is generally interpreted as residuum, but has been considered till remanents by some geologists: geest is the residuum from solution of underlying dolomites; it is largely Tertiary in age. Evidence from this study supports the view that the major part of the Driftless Area was never glaciated (Fig. 12). The report has been completed and will be published as an ISGS Circular.

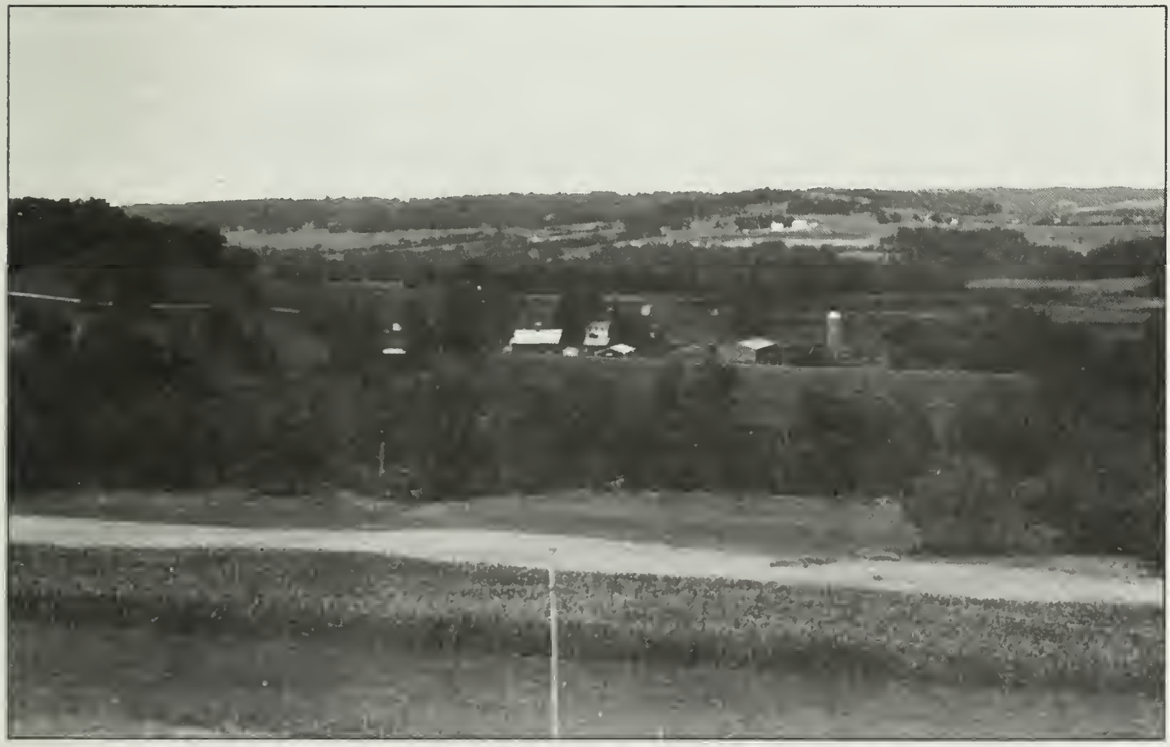


Figure 12. Driftless Area of northwestern Illinois. Hilly terrane north of Elizabeth in Jo Daviess County.

Loess Stratigraphy and Glacial History of the Lower Mississippi River Valley (Willman and Frye). More than 20 years ago the authors began a study of the loess stratigraphy of the lower Mississippi Valley. In subsequent years, the project was extended southward to revise earlier work on the lower valley. As a result, the study now includes a general history of the lower Mississippi River region extending from southern Illinois to northern Louisiana. New samplings and revisions were made in 1983. The manuscript will soon be completed for publication as an ISGS Circular.

Loess Stratigraphy of the Mississippi Valley (McKay, Follmer, Glass, and Willman). Stratigraphic studies are being conducted to correlate major loess units of Illinois with the thick loess deposits of the lower Mississippi Valley. Large exposures have been sampled in Arkansas, Tennessee, Mississippi, and Louisiana. A previously unknown pre-Illinois loess deposit has been discovered in western Mississippi. Detailed knowledge of the stratigraphy of the loesses of the lower Mississippi is important to understand the complex geologic relationships of loesses and the glacial deposits with which they are interlayered in Illinois. This report will be an extension of the preceding Willman and Frye report.

Pre-Illinoian Loesses of Illinois (McKay and Glass). Many pre-Illinoian silt deposits occur along both modern and ancient river courses in Illinois. In past studies, they have been largely overlooked, despite their significance to land use, engineering applications, and geologic history. This study attempts to identify ancient loesses and to determine their properties and extent. Two thick deposits have been identified in the bluffs near Collinsville, Illinois. As the study continues, these deposits will be correlated with others along the Illinois Valley and with formally named stratigraphic units (Petersburg Silt, Loveland Loess, and Harkness Silt).

Wilsonville/Paddock Creek Data Comparison (Killey, Glass, and Follmer). The Wilsonville hazardous-waste site investigation has stimulated basic stratigraphic research. Field logging a single hole drilled to bedrock at Wilsonville supplied data that allowed completion of the Quaternary System geologic column in this area. These data resolve some statigraphic questions posed by data from the nearby Paddock Creek section in Madison County. The study will also compare data from two sections east of the Ridged Drift area. This project contributes to the data base for future stratigraphic studies of the extent and nature of Illinoian and pre-Illinoian glacial sediments across southern Illinois.

Stratigraphy of Illinoian Glacial Deposits, Southwestern Illinois (McKay, Killey, and Glass). Glacial deposits are being correlated between localities where a substantial data base exists and can be used to establish the stratigraphic succession and the composition of individual geologic units. This effort focuses on three benchmark locations; the Wilsonville, Paddock Creek, and Maryville sites in Macoupin and Madison Counties. It will be extended to include at least 12 additional sites in southern and southwestern Illinois where data have been collected, but have not been synthesized into a model of regional distribution of glacial deposits.

Geology of the Oak Crest Bog, Winnebago County, Illinois (Berg, Follmer; King, Illinois State Museum; McKenna, Northern Illinois University). We are investigating the geology of a peat bog between 47,000 and 25,000 years old. It is the northernmost bog deposited during that period in North America; thus it is extremely significant for understanding galcial history. To assist us, Dr. James King of the State Museum has performed pollen analyses.

The bog is located beneath a housing subdivision and is creating problems for septic systems. If we can accurately determine the extent of the bog, we can identify areas where septic systems can be safely installed.

Revision of the Glacial Stratigraphy in North-Central Illinois (Kempton, Berg, Follmer, and Glass). The study is part of a revision of ISGS Circular 437. Because of the large volume of new data from the Boone-Winnebago project, the nomenclature in glacial stratigraphic relationships of north-central Illinois required revision. In the report, many previously misinterpreted geologic units are reclassified.

Wedron Formation Project (Killey, Kempton, Hansel, Glass, and Follmer; W. H. Johnson, University of Illinois; and others). This study is continuing on a project-by-project basis. Eventually, the stratigraphy of the Wedron Formation will be updated to establish a classification that can also be used for applied research.

Stratigraphy of the Wedron and Trafalgar Formations (Wisconsinan) in East-Central Illinois and West-Central Illinois (Kempton, Bleuer, and W. H. Johnson). A GSA field trip was planned to summarize information and ideas about the Wedron and Trafalgar Formations and their relationships. The guidebook will be reformated and published as an ISGS Circular.

Revision of the Glacial Stratigraphy in South-Central Illinois (Kempton, Berg, Follmer, and Glass). The Louisiana Land and Exploration Company, New Orleans, requested information on the bedrock surface to aid in interpreting seismic data. Samples from 64 shot holes, provided by LL and E, gave us a unique opportunity to study the drift stratigraphy in Bond and Clinton Counties. Samples from all 64 holes were described; cross sections for 10 seismic lines were prepared from the sample descriptions and drillers' log. Glasford and Banner Formation tills were identified. Letter reports and cross sections were provided to LL and E.

The Tiskilwa Till Member: A Regional Study (Wickham and Kempton; W. H. Johnson, University of Illinois). This study, which was completed as a Master's thesis at the University of Illinois by Wickham (1979), is being reviewed for use as a source document for the Fermilab project. Because of its significance, the manuscript will be published as an ISGS Environmental Geology Report.

Paleozoic Stratigraphy

Middle Ordovician K-bentonites of Eastern North America--Correlation by Chemical Fingerprinting (Kolata and J. Frost; W. D. Huff, University of Cincinnati). In the past year, results from this ongoing investigation demonstrated the effectiveness of chemical fingerprinting in the regional correlation of Ordovician K-bentonites (altered volcanic ash) in eastern North America. Chemical signatures of individual K-bentonite beds have not been identified over long distances in the Mississippi Valley, in the region of southern Ohio to central Tennessee, and in Pennsylvania. From January through December 1983, 79 samples from the Mississippi Valley and 100 samples from the eastern states as well as Ontario and Quebec were analyzed for 24 elements by instrumental neutron activation. These data are presently being statistically analyzed. The results should extend the correlations over even greater distances.

Compendium of Ordovician K-bentonites of North America (Kolata; W. D. Huff, University of Cincinnati). Most literature about Ordovician K-bentonites in North America discusses the stratigraphic occurrence and/or mineralogy of K-bentonites in limited geographic areas. This literature is found in obscure journals, reports, and theses. We are presently compiling an annotated bibliography that will guide students of Paleozoic-altered volcanic ash. Maps showing the locations of reported K-bentonites along with regional stratigraphic columns will be included in the final manuscript, which will be complete by the fall 1985.

Because these K-bentonite beds represent instant time events, they provide time planes to which geologic events can be referred. They also provide data for mapping areas that potentially contain natural gas and oil.

Within the past year, 2 published papers and three presentations at scientific conferences have resulted from this study. At present, a summary of the Mississippi Valley work is in preparation. Also, a proposal has been submitted to the National Science Foundation for continued support of this project.

Feldspathization of Middle Ordovician K-bentonites--Nature, Age, and Origin (Kolata; R. Hay, University of Illinois). Certain Middle Ordovician K-bentonites (altered volcanic ash) beds in the Upper Mississippi Valley region have been altered to potassium feldspar (Fig. 13). The distribution of the K-feldspar indicates that it has stratigraphic and geographic significance. Through oxygen isotope studies, potassium-argon dating, and petrographic analyses, knowkledge can be gained concerning the nature, age, and origin of these beds. Results of this investigation could have implications for the occurrence of K-feldspar in Paleozoic rocks.

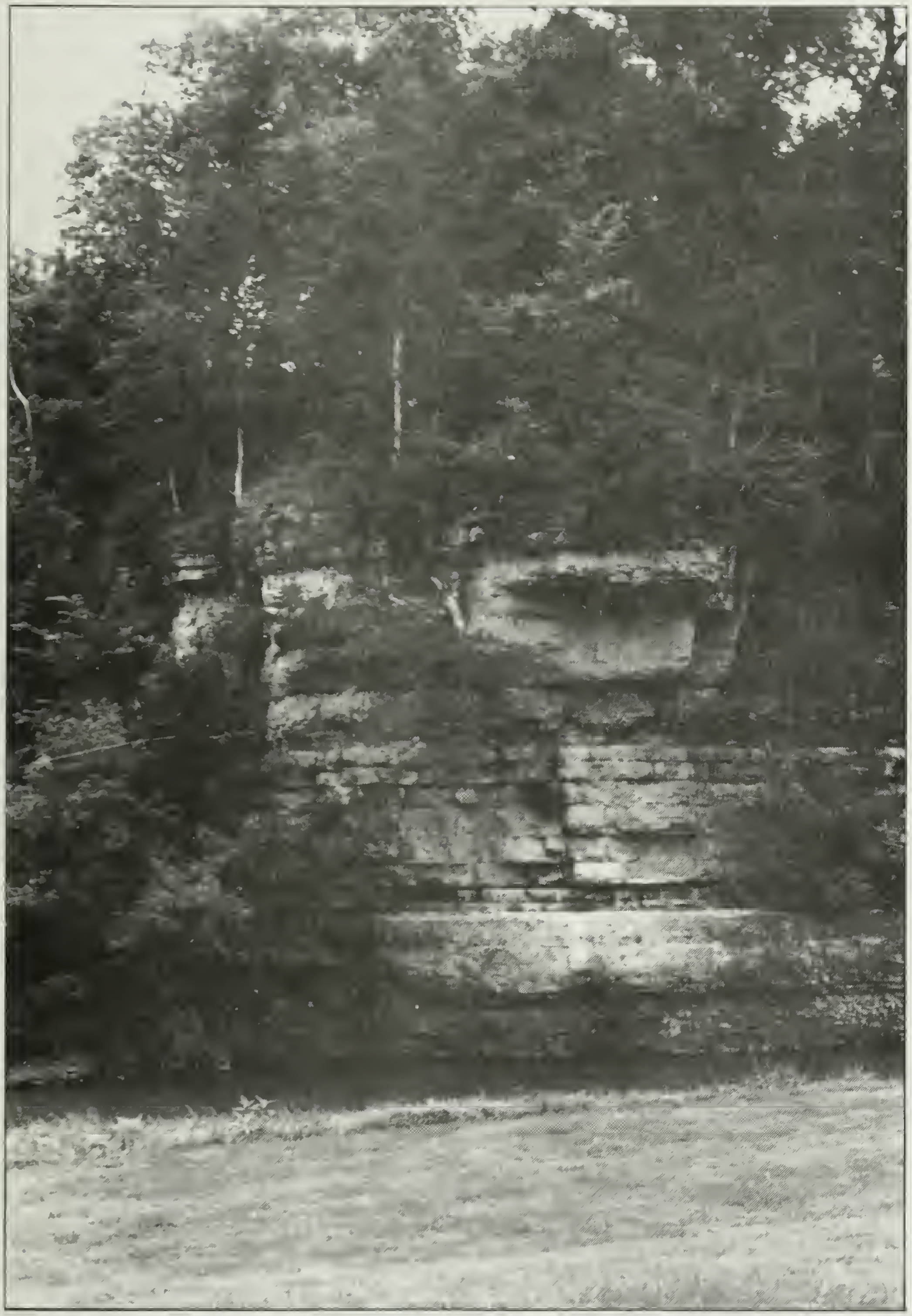


Figure 13. Wise Lake Formation, Apple River Canyon State Park: exposed rocks contain K-bentonites, which are under study.

Biostratigraphic Correlation of Chicago-Area Silurian Rocks (Mikulic and Sargent). This study will review and revise the lithostratigraphic and biostratigraphic framework of Silurian rocks in northeastern Illinois. These rocks are of special importance to construction engineers and crushed rock producers in the area. Many quarries have been expanded in recent years, presenting opportunities for new studies. Work thus far has consisted mainly of quarry descriptions. Core studies will follow. Data obtained here will be used to extend correlations throughout the state.

1985 North-Central GSA Field Trip - Silurian Sedimentation and Stratigraphy, the Silurian-Ordovician Disconformity, and the Tectonics of the East End of the Sandwich Fault Zone (Mikulic, Sargent, Norby, and Kolata). The ISGS is organizing a field trip for this area. Current research is being incorporated into the field trip planning.

The Mississippian-Pennsylvanian Boundary in Southern Illinois (Baxter, Collinson, Howard, Jacobson, Norby, and Trask). The physical evidence for a conformity between Mississippian and Pennsylvanian sediments is inconclusive, but conodont evidence reported by other workers suggests no apparent time gap. The conodont evidence is being reevaluated and other data gathered.

Stratigraphy and Depositional Environments of the Mississippian Fraileys Shale and Haney Limestone, Illinois Basin (Treworgy). This study will identify facies of the Mississippian Fraileys Shale and Haney Limestone in the Illinois Basin, map their distribution, and determine the environments of deposition. Providing a detailed paleonenvironmental framework should help to locate or predict potential stratigraphic traps for hydrocarbons in these and stratigraphically similar units.

Field work in southern Illinois and adjacent parts of Indiana and Kentucky and petrographic studies of the samples have largely been completed. Regional cross sections have been constructed using geophyscial logs from oil tests to extend outcrop information to areas with subsurface data. Thin, distinct limestones in the Fraileys Shale might be storm deposits that extend over large areas; if so, they may be used as time lines. Such markers provide valuable information for correlating facies and unraveling geologic history.

St. Louis and Ste. Genevieve Limestones in Southern Illinois (Norby and Baxter; Rexroad, Indiana Geological Survey). A study has been initiated to reexamine the Ste. Genevieve Limestone and its boundary with the St. Louis Limestone. Two microfossil groups, conodonts and calcareous foraminifera, will be used as biostratigraphic crosschecks. By obtaining a better definition of this interval, we should be able to determine (1) whether a large time-transgressive boundary exists between the St. Louis and the Ste. Genevieve (similar to that occurring between the St. Louis and Salem), and (2) whether this boundary is primarily synchronous, disconformable, or unconformable.

Standard Reference Section of the Vienna Limestone (Norby and Baxter). A report is nearing completion on a standard reference section of the Vienna Limestone of Mississippian age. The section was carefully chosen and is located only a few miles from the now inaccessible type section described in 1920. A standard reference section is needed for correlation and comparison with rock strata of similar age. The biostratigraphy (conodonts and foraminifera) will be included with the stratigraphic information. The new reference section exemplifies the lithologic characteristics of the type section (determined from field notes), and it has an excellent probability of remaining exposed for many years.

Committee on Correlations in Pennsylvanian System, Illinois Basin

Tri-State Committee on Correlations in the Pennsylvanian System of the Illinois Basin (Jacobson and Trask). This committee is correlating stratigraphic units across the boundaries of the three states in the Basin to reach agreement on a common stratigraphic nomenclature. During the past year, the three states have been resolving correlation problems between coal seams and other Pennsylvanian units. The AAPG Bulletin will publish a description of the committee's work and achievements since 1979. At the last meeting of GSA, the committee presented a paper on its work: basinwide names were proposed for five coal seams and two limestone beds with different names in each state. Currently, the committee is evaluating six more units.

Organization of the Illinois Quaternary Association (Hansel). On March 31, 1983, 40 Quaternarists from Illinois gathered at the ISGS for the first semiannual ILQUA (Illinois Quaternary Association) meeting. This meeting was organized by D. L. Johnson (Department of Geography, University of Illinois) and J. Saunders (Illinois State Museum) as a forum for Illinois Quaternarists. Archeologists, anthropogists, biologists, geochemists, geographers, geologists, palynologists, paleontologists, and pedologists participated and shared research interests. Informal presentations of research were given by Berg, Follmer, Glass, Gross, Hansel, Kempton, and Masters of the ISGS; Coleman and Liu hosted an Open House at the ISGS Isotope Geochemistry Laboratory. Plans for extending a bid to host the 1986 AMQUA meeting in Illinois were discussed and received a positive response. J. Saunders invited the group to the ISM in Springfield in fall 1983 for the second meeting of ILQUA.

Subsurface Geology

Knowledge of the subsurface is gained through acquisition, preservation, and study of borehole samples, cores, geophysical records, fossil samples, and drillers' logs. Some of this data is obtained through scouting efforts. Our specialists are responsible for seeing that valuable data and samples acquired by the Survey are preserved and studied in a timely way.

Subsurface geology as a distinct mission has received new emphasis with the shifting of duties within the Survey and the special cooperation of the staff at the Survey Annex.

North American Craton in the United States: Chapter 11, The Illinois Basin Region (Collinson, Sargent, and Atherton; Shaver, Indiana Geological Survey). This report, which synthesizes information on Illinois-Basin development, provides thickness and structure maps covering Precambrian through Permian time and discusses tectonic episodes, depositional trends, erosional effects, and important resources. The draft manuscript will appear as a chapter in the Decade of North American Geology series sponsored by the Geological Society of America.

Structure and Topography of the Precambrian Surface in Illinois (Sargent and Buschbach). Since the publication of the last map of this major disconformity in ISGS Bulletin 95 (1975), more than 12 new wells have either penetrated this surface or been drilled deep enough to provide a reliable estimate of its location. A continuing interest in developing caverns for storage of wastes or energy-related feedstock has promoted revision of this map.

The Stratigraphy of the Everton Formation in Illinois (Norby, Sargent, and Schwalb). Recent investigations of the Illinois Basin have called attention to the need to identify the thickness, extent, and lithostratigraphic character of the Everton Formation. Recognized along the outcrop belt in southeast Missouri, the Everton has generally been lumped into the Prairie du Chien Group (Canadian Series) in the Sauk Sequence. However, the Everton is Whiterockian (basal Champlainian) in age. It is legitimately part of the Tippecanoe Sequence and should be distinguished from the Prairie du Chien Group.

We have observed that the upper parts of the formation, a mixed lithology of St. Peter-type sands interbedded with dolomite, are easily identified. The lower parts are difficult to distinguish from Prairie du Chien. Well data have also shown that the Everton overlies progressively younger strata of the Prairie du Chien, known only in the subsurface beneath the Everton.

Only one core is known to penetrate a part of the Everton in Illinois: Superior Oil Company (Ford C-17) in White County. Conodonts from test samples indicate the entire 175 feet of penetration to be Champlainian, therefore, Everton Formation. Continuing efforts are being made to correlate the Everton and its overlying and underlying strata to define the important time-stratigraphic boundary at the base of the Everton Formation.

Lithographic Correlations of Silurian Units of Illinois (Sargent, Norby, and Mikulic). In 1975, Willman published Rock Stratigraphy of the Silurian System in Northeastern and Northwestern Illinois (ISGS Circular 479). The report represented a great step forward in understanding Silurian outcrop areas. Identifying strata in the subsurface and correlating the widely separated outcrop areas remain difficult, however, principally due to facies changes throughout the system. Index fossils have not been very useful. Recently, a large diameter core that penetrates the entire Silurian was obtained from Logan County. Acidation of the core provided excellent conodont faunas; coupled to detailed geophysical bed tracing, these promise to give the needed correlations. Studies are continuing.

Subsurface Laboratory (Atherton). Dr. Elwood Atherton, Emeritus, voluntarily supervises the subsurface laboratory and responds to public queries as well as those of the Survey's scientific staff. He shares responsibility for critically reviewing Survey manuscripts to ensure compliance with official stratigraphic policy. During the year he reviewed 32 manuscripts, 14 abstracts, and 10 sets of illustrations. He also proofread 7 reports.

X-Ray Laboratory Clay Mineral Analyses (Glass). This laboratory provides support to the Survey's stratigraphic studies, other investigations, and many outside agencies and institutions. During the past year, more than 4,000 X-ray diffraction analyses of clay were made in response to requests from the Oil and Gas Section, Hydrogeology Section, LUMP, Analytical Chemistry, Geochemistry, Engineering Geology, Coal, and Educational Extention. The main emphasis has been on Pleistocene materials.

Stratigraphic and Subsurface Services

Survey stratigraphic and subsurface specialists received 192 visitors and responded to 88 letters and 275 telephone inquiries during the year. They provided 69 reports on sample analyses, including information on more than 400 X-ray diffraction determinations. Survey scientists gave 23 seminars or lectures, provided guidance to 9 graduate students, addressed the public in 8 talks or interviews, and testified to governmental agencies on 4 occasions.

STRUCTURAL GEOLOGY

During the reporting period the Survey's research on structural geology was supported through the New Madrid Seismotectonic Study funded in part by the U.S. Nuclear Regulatory Commission (US NRC). Administered by Dr. T. C. Buschbach (emeritus) of our staff, the study is a coordinated program of geological, geophysical, and seismological investigations of the area within a 200-mile radius of New Madrid, Missouri. The goal of the study is to provide information on structural setting and tectonic history that will lead to safe siting and construction of nuclear facilities around areas subject to earthquakes.

Participants in the study include geologists from the State Geological Surveys of Illinois, Indiana, Kentucky, Tennessee, Alabama, Arkansas, and Missouri; faculty members of earth science departments at St. Louis University, Vanderbilt University, Purdue University, Memphis State University, the University of Pittsburgh, the University of

Kentucky, the University of Wisconsin at Milwaukee, and the University of Texas at El Paso; and staff members of the U.S. Geological Survey, the U.S. Army Corps of Engineers, and the Tennessee Valley Authority.

Research

Structural Geology in the Vicinity of the Shawneetown Fault Zone, Southeastern Illinois (Nelson and Lumm, with contributions by Stohr, Danner, and others). Geologic mapping of the Rudement, Equality, and Shawneetown 7.5-minute Quadrangle has been completed. The contract report to the US NRC will be submitted in June. There are two conclusions: (1) Southern Illinois and adjacent areas are currently subject to compressional stress oriented east-west to ENE-WSW. These stresses produce small earthquakes and also cause rock failure in north-south headings of underground mines. The maximum force is about 3 times the vertical overburden pressure. (2) Existing faults originated prior to the development of east-west compression and are not properly oriented to be reactivated by the present stress field. Danger of earthquakes is no greater near these faults than it is remote from them.

Structural Geology in the Vicinity of the Ste. Genevieve Fault Zone, Southwestern Illinois (Nelson, Lumm, and Danner). The purpose of this project, which will result in a detailed description of the structural and stratigraphic framework of the region, is to determine the nature, age, origin, and extent of faulting in the Ste. Genevieve Fault Zone in Jackson and Union Counties in order to evaluate the potential for damage from earthquakes in the region. Funded by the US NRC, this study is part of a larger study of the New Madrid seismic zone. Field mapping began in October 1983 and should continue through spring 1984. The two major tectonic structures in the area, the Rattlesnake Fault and the Pomona Fault, have been mapped and described in detail. The present focus of the project is to delineate minor structures related to the two faults.

Tectonic History and Sedimentary Geology of the New Madrid Seismic Zone (Buschbach and Schwalb). The Reelfoot Rift and the Rough Creek Graben in western Kentucky and southeastern Missouri were depocenters from early and middle Precambrian until late Mississippian time when the main depocenter moved northward into southern Illinois. This study of their tectonic and depositional history was completed in March and will be published in the Missouri Academy of Science Transactions.

PALEONTOLOGY/PALYNOLOGY

Paleontologic/palynologic studies provide tools for stratigraphic correlation and mapping and for interpretations of earth history. An important aspect of many Survey stratigraphic, biostratigraphic, mapping, and resource studies, they yield unobtrusive yet significant scientific information contributing to Survey programs.

Seven scientists are involved in paleontological and palynological research: Dr. Peppers supervises the Palynological Laboratory; Dr. Kent manages the Paleontological Repository; Dr. Baxter supervises the Foraminifera Laboratory; Dr. Norby supervises the Conodont and Acid Laboratories; Dr. Kolata specializes in Ordovician macropaleontology; Dr. Mikulic concentrates on Silurian macropaleontology; and Dr. Collinson specializes in Devonian-Mississippian micropaleontology. All seven scientists have other major responsibilities in addition to this specialized research.

The ISGS has the only palynology laboratory in the Midwest that routinely provides age determinations and correlations of Pennsylvanian strata, especially coal. Illinois is considered the principal reference area in North America for Pennsylvanian palynology partly because of its geology, but largely because the Survey has accumulated so much data: the ISGS has had the longest continuing program, pioneering basic palynological research and practical applications. Since about 1946, palynological research has been used primarily to identify and correlate coal beds. Most of the approximately 90 coal beds in Illinois can be differentiated and correlated on the basis of palynological evidence; however, a number of problems remain, especially in the lower and upper parts of the Pennsylvania. Also, additional paleoecological research of the Pennsylvanian coal swamps is required to increase our understanding of peat deposition, distribution of coal resources, and coal quality.

Palynological Studies

Palynological Correlation of Major Pennsylvanian Time Stratigraphic Boundaries Between the Illinois Basin and Other Coal Basins (Peppers). Comparative data from other basins are proving helpful in revising the stratigraphy and correlations of Pennsylvanian strata in the Illinois Basin. Revised correlations have been proposed and tied to correlation of boundaries of the Midcontinent series; major formations in the Appalachian Region; Lower, Middle, and Upper Pennsulvanian series; and stages and substages in western and eastern Europe. A final report on this study is now in preparation.

Palynological Correlations Between Pennsylvanian Coals in the Illinois Basin and Appalachian Region (Peppers and Lowry). A correlation of Lower Pennsylvanian coals in the Illinois Basin with those in eastern Kentucky by use of spores has been carried out for the first time. Stratigraphic ranges of spores were compared, and it was found that in some cases relative abundances of certain spore taxa were similar. The correlation based on patterns of spore abundance confirms and further refines palynological correlation between coals in Illinois and northeastern Tennessee published earlier this year (Phillips and Peppers, 1984). The similarity in patterns can only be explained as similar responses to climatic changes.

Palynology of Coals at the Desmoinesian-Missourian Boundary (Peppers and Lowry). About 40 samples of coal and coaly shale from a number of localities in the Midcontinent were analyzed for the purpose of defining the position of the boundary between the Desmoinesian and Missourian Series with respect to strata in Illinois. The position of the boundary has formerly been placed at the top of the Trivoli Sandstone, but palynological evidence now indicates that the boundary is lower between the Pond Creek and Lake Creek Coal Members. This is the level at which the most profound and widespread changes in coal swamp floras took place during the Pennsylvanian. The new position also coincides with the time at which a major change in faunal assemblages occurred. The results of this study are being included in a paper that will be part of a special issue of the International Journal of Coal Geology.

Distribution of Major Spore Taxa in the Springfield and Herrin Coal Members (Peppers and Lowry). Several preliminary maps showing the distribution of the most abundant spores in the Springfield (No. 5) and Herrin (No. 6) Coals were prepared. These two coals provide an unique opportunity for studying the relationship of environment to the kinds of plants that produced the peat. Numerous analyses of the two coals are available, and the paleogeography has been supplied by the mapping of channel deposits representing streams that flowed through the swamps. Results of the study show that the thickest coal deposits were formed primarily from the remains of lycopod trees adjacent to these streams. Other plants, especially tree ferns, are associated with thinner accumulations of peat under drier conditions. Analysis of additional coal samples from areas where data are sparse will be undertaken to complete the maps.

Comparison of the Paleoecology of the Springfield Coal in Wabash County, Illinois and Warrick County, Indiana (Peppers and Lowry). A series of bench samples of the Springfield Coal from a mine in Wabash County, Illinois, and Warrick County, Indiana, were studied for environmental interpretations of spore assemblages. These two sites are located along the ancient Galatia stream channel and its distributaries. At the Wabash Mine, downstream from the Warrick County Mine, plants growing along the broad levee were a major influence on the kind of peat that was deposited. On the other hand, trees that grew in water made up most of the coal-forming peat that was deposited in the region of the Warrick County Mine, located upstream in an area of Galatia distributaries. This study was included in a field trip guidebook of the Geological Society of America.

Miscellaneous (Peppers). Ninety-five samples of coal and other rocks were macerated for spore analysis during the report period; most were processed for specific research projects, but others were processed to help correlate coal beds in field mapping or to add to our reference collection for future study.

Macropaleontologic Studies

Paleobiology of the Cornute and Mitrate Carpoids (Kolata). Carpoids are a very rare, enigmatic, extinct group of echinoderms known from Cambrian- to Devonian-age rocks throughout the world. Some of the best preserved specimens occur in Cambrian and Ordovician rocks of Illinois and adjacent states, and some of the finest material is in the paleontological collections of the ISGS. Long-term studies are being conducted of the functional morphology, phylogeny, evolution, and systematics of the carpoids. An abstract that describes the life modes of the cornute and mitrate carpoids has been submitted for presentation of the 5th International Echinoderm Conference in Galway, Ireland, in October.

Crinoids of the Champlainian (Middle Ordovician) Guttenberg Formation--Mississippi Valley Region (Kolata). A report describing a recently discovered crinoid fauna (Fig. 14) from Middle Ordovician rocks in northwestern Illinois, southwestern Wisconsin, and northeastern Iowa has been prepared and submitted for publication in the Journal of Paleontology.

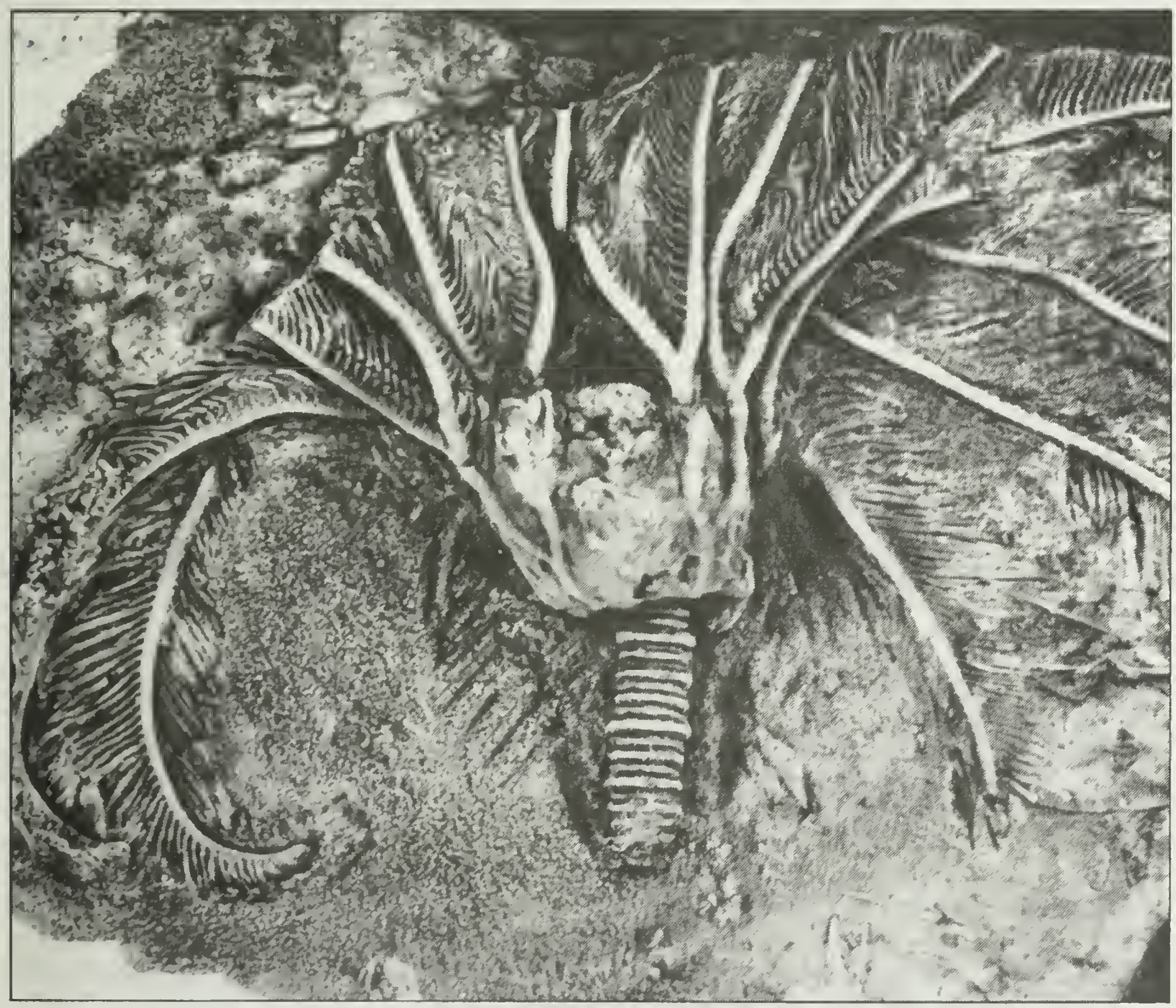


Figure 14. *Pycnocrinus gerki,* a new crinoid species from the Middle Ordovician Guttenberg Formation of northern Illinois.

Micropaleontologic Studies

During the year, the paleontological acid laboratory was reactivated by Dr. Rodney Norby and Michael Sargent. Microfaunal studies from cores for deep basin correlation provide support for the Stratigraphy and Subsurface Geology, Oil and Gas, and Industrial Minerals Sections. Notable among the new microfaunal studies is a project focusing on the acquisition of Silurian and early Ordovician conodont faunas from deep basin cores. In addition, a new series of studies will compare Silurian conodonts from cores collected in west-central Illinois with conodonts from extensive collections from outcrops throughout the region. Also, a cooperative study comparing foraminifers and conodonts from Mississippian cores promises to refine ranges of both groups of fossils.

Biostratigraphy of Ordovician (Champlainian) Rocks in a Core from White County (Norby, Sargent, and Schwalb). Conodonts from an Ordovician carbonate core are being examined to determine stratigraphy more precisely and correlate rocks in the deeper portions of the Illinois Basin. The conodonts also provide a thermal alteration index for these rocks.

Silurian Conodont Succession in West-Central Illinois (Norby and Sargent). As part of a reorganization of Silurian biostratigraphic research, a study of Silurian conodont successions begun by Matthew Avcin early in the past decade has been revived. Most faunas are already in hand and many of the outcrops and several cores have been described. The revived study should provide precise correlation to the Bonner cores of Logan County and the sections in northeastern Illinois that are being studied in connection with a scheduled 1985 GSA field trip. Understanding of the wedge-outs of western Illinois is also an important goal of this study.

Skeletal Apparatuses of Conodont Organisms (Norby). The individual skeletal elements of various Chesterian conodont species have been identified. The elements appear in various recurring patterns, providing an indication of their arrangement within the conodont animal. Several viable hypotheses of their use within the conodont animal are suggested and have been developed into a report to be published by the Survey.

The Burlington-Keokuk Boundary in Western Illinois (Collinson). The deepening of Gray's Quarry at Hamilton, Hancock County, has exposed the contact between the Mississippian Keokuk and Burlington limestone formations. Gray's Quarry is part of the international type reference section for the Mississippian System. The base of the Keokuk formerly was revealed only in the now submerged excavation of the nearby Mississippi River lock and dam. The 20 feet of additional exposed section is being described, and its brachiopod and conodont faunas identified. This part of the section holds the base of an important conodont zone that can help determine the placement of the international Tournaisian and Visean Stage boundary in the United States. The study will be complete by year's end.

Paleontological Repository (Kent). The Paleontological Repository receives, curates, and preserves, as a basic data set, the fossils collected and studied by the staff and those related to Illinois geology that are studied by other scholars. Eighty formally cataloged and curated Survey collections, dozens of uncatalogued field collections (some quite large), and several very valuable major reference collections are in the repository. The Worthen Collection and the Frank Collins Baker Collection are the best known.

Dr. Kent has had main responsibility for the collections since 1956. Drs. Collinson, Kolata, and Norby assist in her absence.

Dunbar-Henbest, Pennsylvanian Fusulinidae of Illinois (Kent). During this past period, Dr. Kent completed the year-long cataloging and curating of the Dunbar-Henbest Fossil Collection, which consists of more than 1,520 entries. The collection is part of a larger study collection that formed the basis for "Pennsylvanian Fusulinidae of Illinois," written by Carl O. Dunbar and Lloyd G. Henbest as ISGS Bulletin 67 (1942). The total collection, distributed among the U.S. National Museum, Peabody Museum of Natural History, and the ISGS, is an important element in the large assemblage of basic scientific reference material entrusted to the ISGS.

Search for Type and Reference Specimens of Spirifer leidyi and Spirifer spinosa for U.S. National Museum Studies (Kent and Collinson). Drs. McKenzie Gordon and W. T. Henry of the U.S. National Museum of Natural History have requested a search for types and reference specimens of spirifer brachiopod types for use in a study of faunas from the Bluestone Gap Member of the Hinton Formation of the eastern Appalachians. The specimens are scattered throught the ISGS collections, the University of Chicago collections, University of Illinois collections, and the Illinois State Museum. Dr. Kent is the Midwest authority on such searches.

Palynological and Paleontological Service Activities

The palynological and paleontological staff provided information to 28 visitors and responded to 19 letters and 44 telephone inquiries. They also participated in three conferences or field trips, one poster session, and one workshop. Dr. Peppers informally advised four graduate students (three who were writing theses on palynology, one a thesis on Pennsylvanian stratigraphy).

COMPUTER RESEARCH AND SERVICE

Many research projects described in this Annual Report require electronic data processing support. Hardware capabilities of the Survey include an 11/34 minicomputer, digitizer, and plotter; our staff of programmers develops the necessary software. We also have access to the Prime 750 at the Natural History Survey and to the IBM 4341 and Cyber systems at the University of Illinois through our RJE (remote job entry) stations. In addition to assisting the scientific staff, the Computer Unit develops methods that enable Survey activities to be conducted more effectively and efficiently.

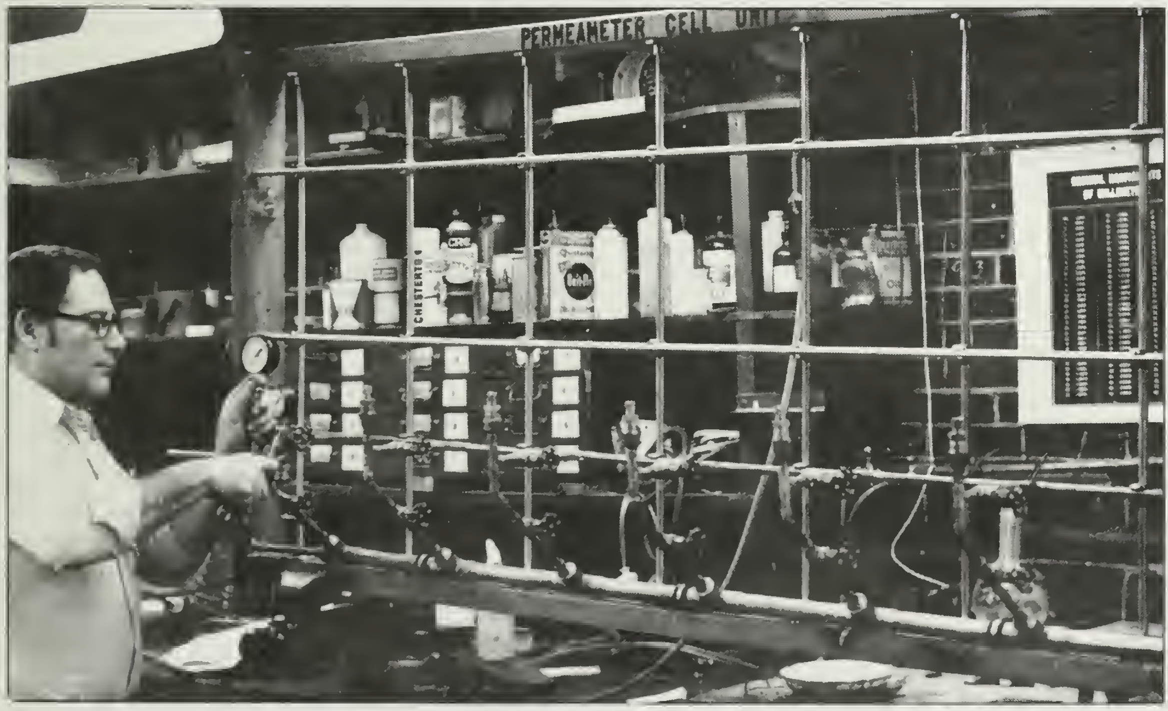
Automation of Geological Records Data Handling (Denhart). The present system of gathering, sorting, processing, and typing data within the Geological Records Unit is repetitious and slow. We have begun designing and implementing an automated procedure on the Prine 750 to replace this manual system.

Service Activities

Programs and techniques developed in support of Survey research can be useful to other organizations in and out of the state. More than 60 copies of ILLIMAP have been sent to groups outside of the Survey; this generates many calls for assistance. Other programs for which we receive requests include our Cornerstone data base management program and our routines for the conversion of X-Y coordinates from one mapping system to another. We also provide support for other state agencies and University of Illinois researchers when they need our expertise or use of our special equipment--we share the use of our digitizer and plotter when it does not interfere with our work.

ADMINISTRATIVE AND SCIENTIFIC SUPPORT SERVICES

Publications Unit: Graphics Department.



David B. Cooley, Supervisor of Technical Design, Operations, and Maintenance.

ADMINISTRATIVE AND SCIENTIFIC SUPPORT SERVICES

Support services include supplying library references and information; receiving and distributing incoming mail; handling and shipping outgoing orders for publications, maps, and other materials; greeting and serving the public through the telephone switchboard and the information office; guiding public field trips, distributing educational materials, and overseeing press relations; preparing and repairing scientific, automotive, and other equipment and instruments; supervising the word processing system; and editing, illustrating, and publishing various scientific communications.

PUBLICATIONS, GRAPHICS, AND PHOTOGRAPHY UNIT

Clear, accurate, and attractive scientific reports are the primary products of the Publications, Graphics, and Photography Unit. Our major series include Circulars, Bulletins, Illinois Mineral Notes, Environmental Geology Notes, Illinois Petroleums, Reports of Investigations, Contract/Grant Reports, Field Trip Guide Leaflets, Guidebooks, Cooperative Groundwater Reports, Reprints, and Oil and Gas Drilling Reports. Other major products include state maps, poster (graphic plus text) sessions, and speech/slide presentations. Our staff also prepares brochures, in-house forms, lists, and signs; edits abstracts, papers, speeches, and proposals; and assists scientists at early stages in the preparation of data for written or graphic presentation. In fact, a continuing dialogue with authors, although time consuming, is the best way to maintain the balance between serving their interests and the interests of their audiences: Illinois agriculture, business, industry, education, and of course, communities and private citizens.

Publications or projects completed from May 1983 through April 1984 are listed in the following pages. Not every type of publication appears every year.

Major Publications/Projects	1981-82	1982-83	1983-84
Circulars	7	5	1
Bulletins	0	0	0
Illinois Mineral Notes	2	4	2
Environmental Geology Notes	3	2	2
Illinois Petroleums	4	1	1
Reports of Investigations	0	0	0
Contract/Grant Reports	6	5	5
Field Trip Guide Leaflets	4	4	3
Guidebooks	1	1	0
Cooperative Groundwater Reports	2	1	1
Reprints	17	9	12
Abstracts	28	25	29

Major Publications/Projects (continued)

Papers (journals, books, and published speeches)	31	41	13*
Oil and Gas Drilling Reports	12	12	12
Poster Sessions	2	7	8
Large Plates	18	18	15
Speeches (unpublished)	0	0	1
TOTAL	137	135	105

The number of products is simply an indicator of the amount of work performed by the Publications Unit. Some jobs take months to complete--some take only a few hours. The magnitude and complexity of a major state map or intricate cross-section cannot compare to a set of graphs. A 70-page manuscript with 21 figures, 7 tables, 1 appendix, and 3 large separate plates (Circular 531) is a large venture, requiring production coordinator as well as a technical editor/writer and layout/pasteup artist. Clearly, a 250-word abstract or 7- to 10-page journal article is a different order of magnitude.

For the preceding year, the staff of the Publications Unit consisted of 2 editors, 1 assistant editor, 2 to 3 graphics artists, 1 typesetter, and 1 photographer.

Survey Publications Released May 1983 through April 1984

Circulars

530. Geologic Distrubances in Illinois Coal Seams. W. J. Nelson. 47 p., 44 figs. (3000)

Illinois Mineral Notes

87. Geology of Carbonate Aggregate Resources of Illinois. J. Goodwin. 12 p., 10 figs. (1400)

88. Geology of Sand and Gravel Aggregate Resources of Illinois. J. Masters. 10 p., 9 figs. (1400)

Environmental Geology Notes

104. Soil, Clay, and Caustic Soda Effects on Solubility, Sorption, and Mobility of Hexachlorocyclopentadiene. S.F.J. Chou and R. Griffin. 54 p., 34 figs., 13 tables. (2000)

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*Papers for outside journals and books no longer are required to pass through the Survey's Publication Unit since they receive outside peer review, especially in refereed journals.

105. Chemical and Toxicological Properties of Coal Fly Ash. J. Suloway, W. Roy, T. Skelly, D. Dickerson, R. Schuller, and R. Griffin. 70 p., 26 figs., 39 tables. (2000)

Reprints

1983D. Factors in Design, Location, and Integrity of Landfills. K. Cartwright.

1983E. Damage that may be Mistaken for Mine Subsidence. R. Bauer.

1983F. The Application of Surface Electrical and Shallow Geothermic Methods in Monitoring Network Design. R. Gilkeson and K. Cartwright.

1983G. Recent Geologic Development of Lake Michign (USA). D. Gross and R. Cahill.

1983H. TGA Studies of Illinois Herrin (No. 6) Coal: Effect of Forms of Sulfur. M. Rostam-Abadi and C. Kruse.

1983I. Methods for Detecting the Mobility of Trace Elements During Medium-Temperature Pyrolysis. R. Shiley, K. Konopka, R. Cahill, C. Hinkley, G. Smith, H. Twardowska, and M. Saporoschenko.

1984A. Sangamon and Wisconsin Pedogenesis in the Midwestern United States. L. Follmer.

1984B. The Origin and Early Genesis of Clay Bands in Youthful Sandy Soils Along Lake Michigan, USA. R. Berg.

1984C. Memorial to John Chapman Frye. H. B. Willman.

1984D. Laser-induced Fluorescence Spectra of Fluorophenol Cations in a Ne Matrix. V. Bondebey, J. English, T. Miller, and R. Shiley.

1984E. Changing Patterns of Pennsylvanian Coal-Swamp Vegetation and Implications for Climatic Control on Coal Occurrence. T. Phillips and R. Peppers.

1984F. Characterization of Coal Chars from a Flash Pyrolysis Process by Cross Polarization/Magic-Angle Spinning ^{13}C NMR. M. Chou, D. Dickerson, D. McKay, and J. Frye.

Educational Extension

Brochures: Geological Science Field Trips; Educational Resources

1983A. Guide to the Geology of the Hardin Area. D. Reinertsen.

1983B. Guide to the Geology of the Crystal Lake-Richmond Area. D. Reinertsen.

1983D. Guide to the Geology of the Golconda Area. D. Reinertsen.

Contract/Grant Reports

1983-1. Surficial Electrical Resistivity and Shallow Geothermic Surveys East of the Sheffield Low-Level Radioactive Waste Disposal Site, Bureau County, Illinois. T. Larson, R. Gilkeson, and P. Heigold. 17 p., 11 figs., and 1 table.

1983-3. A Study of Trench Covers to Minimize Infiltration at Waste Disposal Sites: Task II Report. Laboratory Evaluation and Computer Modeling Trench Cover Design. T. Johnson, T. Larson, B. Herzog, K. Cartwright, C. Stohr, and S. Klein. 94 p., 83 figs. 8 tables, 1 app.

1983-5. Undisturbed Core Method for Determining and Evaluating the Hydraulic Conductivity of Unsaturated Sediments. A. Elseftawy and K. Cartwright. 49 p., 14 figs., 6 tables, 2 apps.

1983-6. Hydrogeologic and Geochemical Studies of Selected Natural Radio-isotopes and Barium in Groundwater in Illinois. R. Gilkeson, K. Cartwright, J. Cowart, and R. Holtzman. 93 p., 13 figs., 3 tables.

1983-7. Identification of Mine Subsidence on Aerial Photographs in Central Illinois. P. DeMaris and R. Bauer. 31 p., 7 figs., 4 tables, 1 app.

Cooperative Groundwater Report

9. Retention of Zinc, Cadmium, Copper, and Lead by Geologic Materials. J. Gibb and K. Cartwright. 113 p., 40 figs., 15 tables, 1 app.

Other Publications and Reports

Oil and Gas Drilling Reports. J.V.D. Berg. April 1983 through March 1984.

Brochures

Earthquakes in Illinois. M. Killey and P. DuMontelle. Camera-ready for Illinois Emergency Services and Disaster Agency (ESDA).

Illinois State Geological Library. M. Krick. State Librarian's meeting.

Major speech with slides: ISGS Serving the State of Illinois/A Healthy Economy and a Healthy Environment. M. W. Leighton, M. Killey, and others. (40-minute presentation; 100 slides)

Poster sessions (major presentations, involving text and graphics):

C. Trask and R. Jacobson. Eastern AAPG

R. Jacobson. GSA.

J. Treworgy and C. Treworgy. GSA.

M. Killey. GSA.

C.-L. Chou and R. Cahill. GSA.

P. DeMaris. GSA.

M. Rostam-Abadi and C. Kruse. Gordon Research Conf.

H. Schwalb. AAPG exhibit.

Proposal: Research Programs for Illinois Basin Coal. W. Wells, C. Kruse, N. Shimp, and J. Goodwin.

Special project: Comprehensive scrapbook of R. Bergstrom's career at the ISGS, including more than 100 screened prints. J. Kempton, J. Lauchner, D. Reinertsen, D. Berggren, and others.

Miscellaneous: Revisions of Survey staff lists (5), invitations, forms, and pre-publication assistance with manuscripts and graphics.

Graphics

Slides			Maps, cross-sections, figures			
Drafted	Typeset	Photographed	For ISGS pubs	For poster sessions	Miscellaneous	Large plates
390	163	2,284	227	84	405	15

Survey Publications completed (not yet in press)

Stack-Unit Map of Illinois: 30 x 50 inches, color plate

Potential for Contamination of Shallow Aquifers from Land Burial of Municipl Wastes. R. Berg, J. Kempton, and K. Cartwright.

Survey Publications in Press

Circulars

531. Geology for Planning in Boone and Winnebago Counties. R. Berg, J. Kempton, and A. Stecyk. 69 p., 21 figs, 7 tables, 1 app., 3 large separate plates. (3000)

533. An Electrical Earth Resistivity Survey of the Ridged-Drift Aquifer Between Macon and Taylorville in Central Illinois. P. Heigold, V. Poole, K. Cartwright, and R. Gilkeson. 23 p., 24 figs. (2000)

Illinois Petroleum

125. Petroleum Industry in Illinois. 1982. Part I--Oil and Gas Developments. J.V.D. Berg. Part II--Waterflood Operations. J. Elyn. 138 p., 2 figs., 14 tables. (2000)

Stack-unit maps of Illinois (for Circular 532)

Plate 1: Potential for Contamination of Shallow Aquifers from Land Burial of Municipal Wastes. R. Berg, J. Kempton, and K. Cartwright. (30 x 50 inches; black-and-white; 4100 copies)

Plate 2: Potential for Contamination of Shallow Aquifers from Surface and Near-Surface Disposal of Wastes. R. Berg, J. Kempton, and K. Cartwright. (30 x 50 inches; black-and-white; 4100 copies)

Survey Publications in Preparation

Circulars

532. Potential for Contamination of Shallow Aquifers in Illinois. R. Berg, J. Kempton, and K. Cartwright. 11 figs., 2 tables.

534. Landslide Inventory of Illinois. M. Killey, J. Hines, and P. DuMontelle. 28 figs., USGS plate.

535. Glaciation and Origin of the Geest in the Driftless Area of Northeastern Illinois. H. Willman, H. Glass, and J. Frye. 10 figs., 7 tables.

536. Coal Resources of Grundy, La Salle, and Livingston Counties. R. Jacobson. 40 figs., 18 tables, 6 large separate plates.

Illinois Mineral Notes

89. Lime and Limestone Markets in Flue-Gas Desulfurization. S. Bhagwat. 6 fgs., 5 tables.

Environmental Geology Notes

106. Collection of Representative Coal Refuse Samples for Leachate Generation Studies. I. Krapac, C. Smyth, and R. Griffin. 9 figs.

107. Geochemical Properties of Coal Wastes and Toxicological Effects on Aquatic Life. W. Roy, T. Skelly, I. Krapac, R. Griffin, D. Dickerson, R. Shuller, J. Suloway, and N. Shimp. 19 figs., 17 tables.

108. Southern Lake Michigan: Evidence for Holocene Lake Level Fluctuations. C Larsen. 11 figs., 2 tables.

Contract/Grant Reports

Structural Geology of Southeastern Illinois and Vicinity. W. J. Nelson. 35 figs., 15 photos, 1 table.

Chemical Composition and Geochemistry of the New Albany Shale Group (Devonian-Mississippian) in Illinois. J. Frost, D. Zierath, and N. Shimp. 20 figs., 15 tables, 3 apps.

Educational Extension

Educational Resources Booklet. D. Reinertsen.

Miscellaneous Reports and Papers

Speech: updated outline. For M. W. Leighton.

Graphics: For C. Ainsworth, W. Wells, W. J. Nelson, H. Damberger, R. Jacobson, L. Khan, W. Roy, W. Dixon, R. Berg, I. Samson, and M. Chou.

Reproductions

The publication staff duplicates material for publications, talks, and exhibits, using Ozalid and Xerox copiers as well as photographic techniques. Services performed by the various duplicating processes are estimated in the following lists.

Photography	1982-83	1983-84
2 x 2 inch slides (both black and white and color)	1,754	2,284
Color film developed for staff	152	163
Photographs for editors	1,987	1,423
Photographs for other staff	3,112	3,294
Prints made	3,083	2,884
Portraits taken	16	36
Color prints made	22	15
Mylars made	81	153

Ozalid

Description of Material Used		Approximate Amount Used 1982-1983	Approximate Amount Used 1983-1984
208-S	42" x 100 yd (1 Roll)	69 Rolls	74 Rolls
108-S	42" x 100 yd (1 Roll)	1/2 Roll	1/2 Roll
102 PC3	42" x 50 yd (1 Roll)	2 Rolls	6 1/2 Rolls

Division by Groups and Sections	Number of Copies Made 1982-1983	Number of Copies Made 1983-1984
Information & Technical Services:		
Oil and Gas	3,995	4,889
Mined-Out Area	495	820
Coal Structure	573	555
Other	327	156
TOTAL	5,390	6,420

	1982-1983 Mylar	1982-1983 Paper	1983-1984 Mylar	1983-1984 Paper
Coal	128	123	387	921
Groundwater	68	127	36	114
Oil and Gas	--	96	--	148
Educational Extension & Public Relations	--	--	--	24
Statigraphy & Subsurface Geology	10	59	39	48
Administrative Services	69	38	3	42
Industrial Minerals	--	46	--	7
Geological Records	--	131	--	43
Subtotal	275	620	465	1,347
GRAND TOTAL		6,010		7,767

	1982-1983	1983-1984
Days of operation of Ozalid Room	52	58 1/2

Production of ozalid maps for distrubition to the public increased by 1,750 copies over 1982-83 levels, but remained 1,100 copies below the level of 1981-82.

INFORMATION AND TECHNICAL SERVICES OFFICE

Information Office

Many people visit, telephone, or write to the Survey seeking maps, publications and answers to questions. To meet the needs of the public, and to protect the research staff from having to answer countless routine inquiries, the Survey maintains an Information Office where general questions are answered and publications and maps are distributed.

During January and February of 1984, more than 400 people visited this office. This sample suggests that more than 2,400 visitors were received by this Information Office each year.

During the same sample period, the Information Office handled about 500 telephone orders for publications and maps, and 350 mail orders. These figures indicate that the Information Office handled a total of about 5,100 telephone and mail orders during the year. Orders taken by other staff members often are handled by the Information Office. Most do not require letters, but when necessary, letters are composed. During the 2-month sample period more than 50 letters were written for this purpose. Together with mail orders, we responded to more than 2,400 written queries during the year.

The Survey's telephone switchboard handled approximately 7,752 incoming calls during the 2-month sample period. This projects to a yearly total of 46,512 calls to the Survey. Long distance calls account for about half the total.

Mail Room

The mail room is the central distribution point for publications and maps of the Geological Survey. Stocks of all in-print publications are maintained so that they can be mailed out, or given to the Survey staff, when needed. The mail room also maintains a stock room for all office supplies required by the Survey staff.

Maps and Publications Distributed
ISGS Publications - 14,528
ISGS Maps - 1,189
USGS Maps - 15,869
ISGS Blue Line Maps - 5,624

Postage Meter
Individual pieces run through machine - 65,305
Amount of Postage used - $13,020.03

Individual Orders Filled

April 1983	610	October 1983	653
May 1983	491	November 1983	472
June 1983	484	December 1983	378
July 1983	400	January 1984	561
August 1983	524	February 1984	618
September 1983	1054	March 1984	563

Total - 6,338

Current Inventory of 7.5 minute maps - 54,000
15 minute maps - 6,600

Copy Machines
IBM Copier II - 183,207
Pitney-Bowes - 207,446 (since July 1983)

Duplicating Services
Number of plates run - 2,396
Number of impressions - 1,882,804

The inception of the Natural Resources Information Fund (NRIF) in Fiscal Year 1985, and a recent change of procedures for copying well records, will significantly increase the responsibilities of the Information and Technical Services (ITS) unit. A substantially higher level of record keeping and inventory control will be necessary to monitor the flow of checks and money and the numbers of publications sold. Personnel of ITS also will be involved in operating the copying service for well records and in supervising the maintenance and supply of the copying machine(s) for this service.

Internal Services

Several units in Administrative Services function primarily for the benefit of the Survey's internal operations: the Word Processing Center, Technical Records Office, and Technical Design, Operations and Maintenance shops.

WORD PROCESSING CENTER

The Word Processing Center serves the entireSurvey by supervising the operation and maintenance of the word processor as well as by providing expert operations to enter documents.

On January 12, 1984, the original NBI OASys 8 central processing unit (CPU) was replaced with a new NBI System 64. This change increased the available storage capacity of the CPU and the number of available terminal ports.

The Word Processing and Computer Committees will continue to coordinate efforts to provide greater access to word processing capability for the scientific staff.

TECHNICAL RECORDS OFFICE

The Technical Records Office of the Survey serves as a library of correspondence. Copies of nearly all outgoing correspondence are filed by subject and cross-referenced with a card index. The Technical Records Office also opens and routes incoming mail to the appropriate person or office. Money and checks sent to the Survey for payment of invoices are intercepted and turned in to the Financial Office each day.

With the retirement of Miriam Hatch on March 1, 1983, staff of the Technical Records Office was reduced from three to 2 persons. To absorb the staff reduction, some changes in operating procedures were necessary. During January and February 1984, the staff counted the incoming mail to provide data for an annual projection. In past years, this count lasted 3 months. Previously, many pieces of mail were extracted and processed individually. For example, water well permits received in large batches once each month were formerly counted as individual pieces of mail. This kind of detailed handling is no longer possible. For this year only, a count was kept of both the separately addressed envelopes received, and of the individual items contained in those envelopes. In the future, only the "envelope" count will be used.

Based on the 2-month sample, the following annual totals are estimated for the reporting year: pieces of mail handled, 162,768; envelopes handled, 89,154; mail returned to Records for filing, 21,072; items received that are not normally filed in Records (well logs and permits, invoices, catalogs, brochures, advertisements), 141,696; "envelopes" for items not normally filed, 68,082; items received for the library, 6,450; items of personally addressed mail, 6,720.

TECHNICAL DESIGN, OPERATIONS AND MAINTENANCE

The Technical Design, Operations and Maintenance shops provide many special services for the Survey that would otherwise have to be handled through contractual services of the University of Illinois or the state at much greater cost. Survey shop personnel install and maintain the air conditioners; repair, install, maintain and move office and laboratory furniture and fixtures; unclog drains, and otherwise care for all parts of the Survey's laboratories and offices that are not the property of the University.

Shop personnel also provide custom fabrication of laboratory equipment and furniture. Among the more noteworthy jobs during the reporting period were the following:

1) design modification, machining and fabrication of 2 shakers used for ASTM toxic materials extraction tests (Fig. 15).

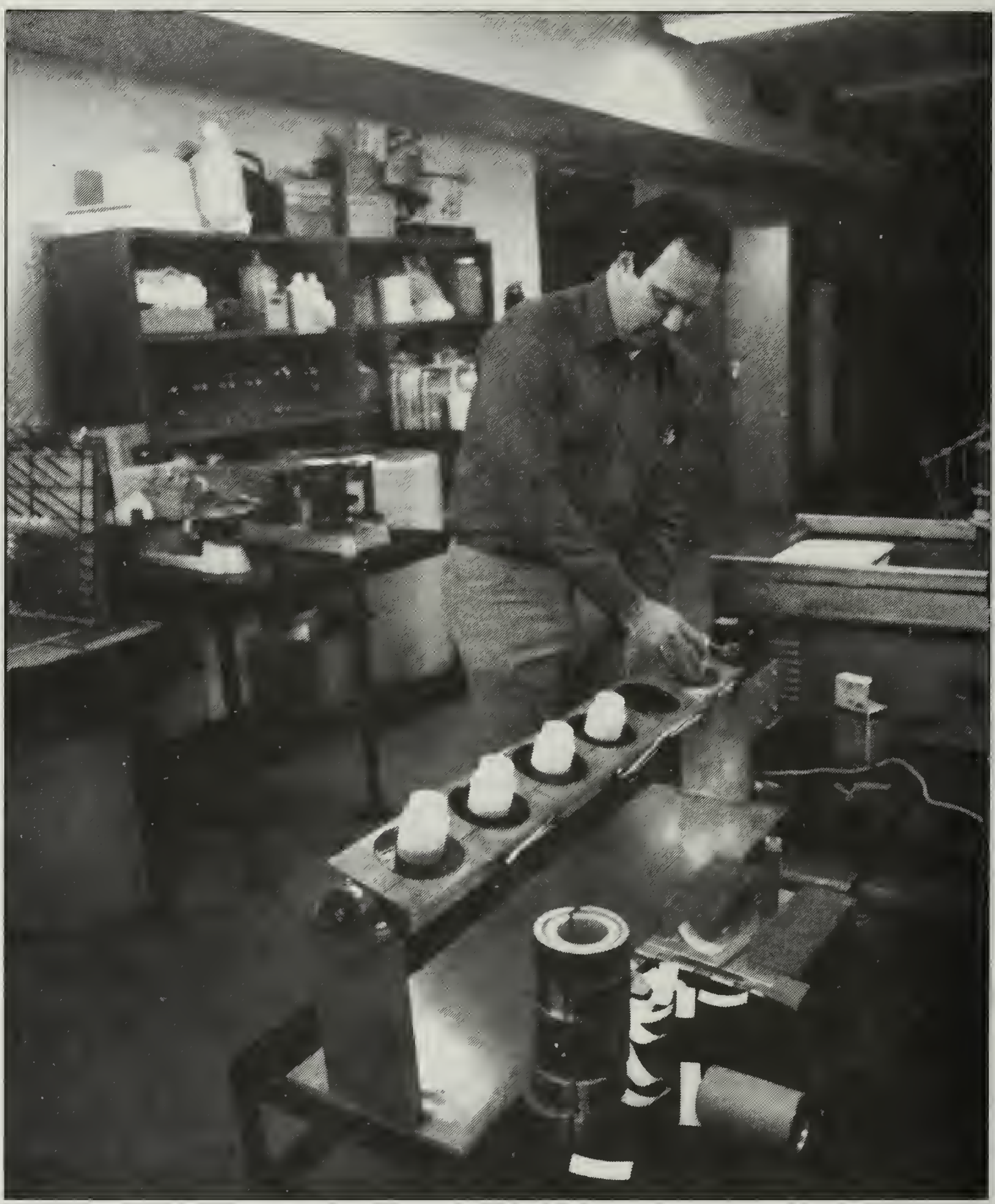

Figure 15. This adjustable shaker was produced by David B. Cooley in the Survey's machine shop for use in the organic geochemistry laboratory. Many man-hours of machining and milling were necessary to form the specially sloped aluminum parts. Jonathan H. Goodwin, Assistant to the Chief, is examining the equipment.

2) fabrication of a triaxial cell for testing of sample permeability and adaptation of the cell's control unit.

3) machining of 6 sample holders and a loading funnel for the x-ray diffractometer laboratory

4) construction of a special table for the low-temperature ashing units

5) design and fabrication of 3 special wooden cabinets with drawers and doors.

A total of 147 repair or fabrication jobs covered by work orders were completed this year. These numbers do not include the many jobs done by oral request, and the regular maintenance procedures that are interspersed with the more elaborate shop work.

Automotive

On May 3, 1983, the 1,000 gallon gasoline tank was replaced at a total cost of $1,800.00. Leaks in the 43-year old tank were discovered early in 1983 when personnel in the Computer Services Unit in the basement began complaining of persistent gasoline fumes. Cost of the tank replacement was shared with the Natural History Survey.

Two new vehicles were received in 1983, a 4-door Dodge Omni and a 5-passenger Dodge van. Two additional vehicles, a 1984 Chevrolet Cavalier sedan and a 1984 Oldsmobile 4-door station wagon are on order for this year to replace the two 9-year old Plymouth sedans.

Since October 17, 1983, when the Department of Central Management Services adopted more flexible policies, Chris Wilson, automotive technician for the Surveys, has performed many of the basic maintenance and inspection services formerly handled by the garage on North Market Street. Having Chris perform oil changes, lubrication, and other services has saved the surveys a considerable amount of money; but it has meant that Chris has less time available to assist in the instrument shop.

Beginning with the reorganization on February 1, 1984, responsibility for keeping the records for the Geological Survey's automotive fleet was transferred to Chris Wilson. Approximately 3 man-days per month are required to prepare the cost reports, milage reports and other records kept by the Geological Survey for its vehicle fleet. We will be examining these reports to see if they are all still necessary, or if there might be a simpler way to prepare these records.

LIBRARY

The Survey Library is designed to provide Survey staff with information to support their research needs. As of February 1, 1984, the Map Room and Library merged to become the Library. This has placed both libraries under the direction of a professional librarian and will provide a coordinated acquisition program to prevent duplication and gaps in the collection. It will allow for increased integration of reference services and will provide greater flexibility in space and operation. A preliminary evaluation of maps to be transferred to the Map Room and manuscripts to be transferred to the Library has been completed. This transfer of nearly 2,500 materials and associated records is expected to be completed in May.

Operations

The library continues to provide a wide range of services to Survey staff. Journals, bibliographies, and other materials are routed to alert staff to new work being done in their fields. The librarians consult with researchers on their specific information needs; locate articles, reports, and books; verify and complete citation; borrow materials on interlibrary loan; prepare bibliographies on requested topics; conduct on-line literature searches, instruct staff in the use of the Library and its resources; and suggest additional information sources. A clippings file has been established to keep articles from news sources about the Survey and its staff. Our on-line searching service has improved with access to the BRS data base system through the University of Illinois Library. Not only can we access additional data bases, but our costs will be lowered according to the total University of Illinois Library use because BRS offers a fee schedule based on use. This will result in a substantial savings for our researchers searching BRS data bases (Fig. 16).

The Library focused a major effort this past year on finding missing items, weeding outdated, unused materials, and reducing the cataloging backlog. After last year's "Inventory of Materials Checked Out", a list of items identified as missing was circulated to Survey staff to be searched for in their offices. The Library was also searched. Such a search for missing items had not been conducted in the past 15 to 20 years. Twenty-one percent were found, 10 percent were replaced, 65 percent were withdrawn from the collection and the remaining 13 percent will be searched again this year. It was sufficiently successful to be repeated annually. This year's "Inventory" is in progress.

The weeding program begun in 1982 to create sufficient space in the Library to house another 5 year's growth was completed in February. The actual shifting of materials is scheduled for May and June.

The Library received a record number of gifts this past year: 3 boxes from Dr. William H. Smith, 10 boxes from Dr. Simon, 5 boxes from Dr. Bradbury's office, 2 boxes from the Mineral Economics office, 1 box from the Water Resources Center, and 33 boxes of Dr. Frye's collection.

With the exception of the Frye collection, which was received in March, all have been sorted and processed.

In addition to processing gifts, the previous cataloging backlog was reduced to five boxes. Six boxes and six shelves remain. In the Map Room more than 1,800 aerial photographs were cataloged in addition to routine work. This February the Library gained limited access through the University of Illinois Library to OCLC, an on-line cataloging data base. This access is expected to reduce cataloging time.

An interim solution to the catalog-card production backlog has been reached since Lincoln Trail Libraries System agreed to print multiple copies of our library cards on a complimentary but temporary basis. Although we must still add some information to each printed card, and the cards are of inferior print quality, this has cut the backlog by almost one-third. A computerized card printing program is being developed.

Figure 16. Library: Mary P. Krick, Head Librarian, and Michael L. Sargent, Stratigraphy and Subsurface Geology Section.

Other Activities

The Library, in cooperation with Dave Gross and Paul DuMontelle, has begun investigating methods of developing an on-line bibliographic data base which would include all publications on Illinois geology. This would be searched on demand to provide information concerning all aspects of Illinois geology to scientists, government agencies, planners, and the public. A second application would be to print and publish a copy, possibly as ISGS Bulletin 96: "Bibliography and Index of Illinois Geology Through 1983" or "Bibliography and Index of Illinois Geology 1966-1983." Computer tapes to be purchased from the American Geological Institute would provide between 60 and 70 percent of the available citations from 1927 to 1983. A study to determine the most efficient software for use on the available computer is underway. If the tapes from A.G.I. appear suitable, we can devise a suitable plan for adding the necessary additions from the Illinois literature and we can find suitable software, this project would be loaded on the Prime 750 system.

Library Operating Statistics

	1983-84	1982-83	1981-82	1980-81
Acquisitions				
Total	4,164	4,372	3,356	3,953
Books	75	25	20	63
State documents	548	368	565	663
U.S. documents	647	799	654	797
Canada documents	128	201	186	169
Miscellaneous documents	234	165	275	268
Manuscripts	4	11	28	34
Maps	623	2,748	1,605	1,704
Field notebooks	7	5	3	23
Photographs and slides	1,898	50	20	232
Total items withdrawn	1,006	5,241	0	939
Serial titles, newsletters received	290	331	331	322
Library circulation				
Total	3,615	4,886	4,731	5,659
Books, documents, serials, misc.	2,218	2,944	2,676	3,122
Maps	1,193	1,687	1,429	1,478
Field notebooks	48	167	63	112
Photographs and slides	156	88	563	947
Visitors	361	560	594	598
On-line literature searches	70	31	14	37

Library Operating Statistics (continued)

Interlibrary loans				
Total	415	448	417	562
University of Illinois	323	-	-	-
Lincoln Trail Library System	92	-	-	-
Reference questions	271	366	350	308
Periodicals routed (not counted in circulation statistics)	2,344	2,265	2,640	2,511

EDUCATIONAL EXTENSION AND PUBLIC RELATIONS

The Educational Extension and Public Relations Unit provides information and materials on the state's geology, mineral resources, and landscape to elementary, high school, and college science teachers, as well as to interested laymen and students. In addition, the staff is available to present slide-illustrated talks concerning research and service activities of the Geological Survey to science teacher workshops, high school science classes and clubs, and citizen groups throughout the state.

Geological Science Field Trips (Reinertsen, and others). These field trips, although open to the general public, are designed for teachers so as to furnish them with background material on the geology, mineral resources, and landscape of Illinois for classroom use. A guide leaflet containing detailed descriptions of points of geological interest is prepared and distributed to the participants. Additional guide leaflets from about 85 previously held field trips are maintained on permanent file so that teachers and others may obtain them for later use. During the period of this report, an average of about 95 of these older guide leaflets were distributed per month.

Attendance for the geological science field trips held during this report period totaled approximately 470 compared with 449 for the 1982-1983 report period. Individual field trip attendance figures were as follows: Crystal Lake-Richmand Area (May 14), 158; Lewistown-Spoon River Area (October 22), 90; Golconda (November 5), 125; and Greenville (April 21), 91 (estimate).

Correspondence (Carlisle and Reinertsen). More than 1,200 mail inquiries from the general public were received to be answered either with a letter or with publications. About half of these requests were from schools, other educational groups, and libraries. More than 175 long distance telephone inquiries were answered, many by sending publications. More than 205 individuals came to the unit office seeking information and material.

Distribution of the Educational Series booklets totaled approximately 550 copies. About 25 topographic map sets made from out-of-date topographic maps were distributed to Illinois schools during this report period. The "Guide to the Use of Illinois Topographic Maps" accompanied the sets. More than 60 additional copies of this guide were furnished to teachers. More than 150 copies of the "Landforms of Illinois" map by James A. Bier (Department of Geography, University of Illinois) were distributed this past year.

Rock and Mineral Sets (Zelinsky, Klitzing, McKinney, and Carlisle). The free set of 35 labeled rocks, minerals, and fossils distributed to Illinois schools, scout councils, and other educational groups, is designed primarily for classroom display purposes and for aid in identifying unknown rocks brought in by students. The sets are distributed at the rate of one per school or one per 500 in enrollment. Zelinsky, Superintendent of the Geological Samples Library, supervises the assembling of the materials under the guidance of the Educational Extension and Public Relations Unit. During this report period, approximately 130 rock and mineral sets plus 17 orders for replacement specimens were distributed to Illinois institutions. In addition, some 45 coal ball slices were sent to Illinois schools.

Geological Science Teaching Aids (Reinertsen). The Survey mailed an abbreviated revised list of services offered to Illinois schools and teachers to each public and private school in the state and to the regional superintendents. The bulk mailing totaled more than 7,300. The list is also distributed at teacher's meetings. The list includes nontechnical Survey publications, maps, and services suitable for elementary and secondary school use.

Educational Exhibits (Reinertsen). Educational exhibits on the geology of the state and the research and service activities of the Survey were displayed at Illinois Oil and Gas Association annual meeting (Robinson, June 23); and the Illinois Science Teachers Association annual meeting (Normal, October 14-15). In addition, representative educational materials were assembled for display during the visits of personnel from the Governor's Office and local legislators. Assistance was also furnished to other sections and groups in the Survey with their respective displays for these visits. The Engineering Geology Section's exhibit concerning geologic hazards was displayed at University Inn, Champaign, for the Board of Natural Resources winter meeting.

Lectures (Reinertsen). Presentations were made to the following groups: Earth Science Club of Northern Illinois (Elmhurst, June 10); Sangamon State University (Springfield, June 20); Illinois Advisory Board on Conservation Education (Springfield, October 18).

Press Relations (staff). A telephone interview with a Chicago area freelance writer concerning rockhounding in Illinois led to an article in a Chicago newspaper that was later picked up by a Boston paper. Four press releases concerning field trips were sent through either the Illinois Information Service, Springfield, or the University of Illinois News Bureau. Two other press releases concerning awards and recent publications have passed through this unit to the University of Illinois

News Bureau which has material in hand for another publication release, plus a feature story on the samples library. A tour of the Survey, Applied Research Laboratory, and the Annex was given to two members of the University of Illinois News Bureau.

Other Activities (Reinertsen). Three student groups, including a landscape architecture class, were given tours of the Survey. At a field conference sponsored by the U.S. Forest Service, Federal Highway Administration and Illinois Department of Transportation in the LaRue-Pine Hills Area of the Shawnee National Forest, Dave Reinertsen represented the Geological Survey. The purpose of the conference was to acquaint people with existing patterns of traffic flow and road locations and surfacings in the area, and proposed road relocations and upgrades. Neighbors, representatives of conservation groups and others were invited to attend the 1-day conference and field trip to learn more about the geology and ecology of the area. Participants were invited to comment on the proposals presented so that sponsors might be better able to select a course of action that would have the least adverse affects on the area.

RECOGNITION AND SERVICE

Donald R. Dickerson was selected to become a "Fellow of the Academy" of the Illinois Academy of Science at their annual meeting in De Kalb Illinois, April 1984. This award honors those members who have made outstanding contributions to their area of research and/or service to the State Academy of Science.

RECOGNITION AND SERVICE

COMMUNICATING WITH INDUSTRY, GOVERNMENT, AND THE PUBLIC

The Illinois State Geological Survey is actively working to provide information on the state's natural resources to the public, business, and government. We have a long history of service to citizens of the state as a scientific organication, not a regulatory body. We are a research as well as a resource institution, providing scientific information as well as collecting it.

This report documents the Survey's efforts to develop new scientific data, enhance and maintain its data base, and disseminate information. Disseminating information on the state's economic development and its quality of life is essential. We are addressing the issue of information service in a number of ways:

- reports and publications that reach a wide audience,
- field trips,
- exhibits both at scientific and public functions,
- press, radio, and TV interviews and presentations,
- talks given statewide at various levels and segments of our society,
- responses to inquiries by telephone, letters, and visitors.

Visiting with the public, industrial representatives, and government officials is especially helpful. We welcomed the visits this past year of representatives from industry--those anxious to help develop the state's fossil fuel and mineral wealth, and those concerned with protection of the environment, waste management, groundwater contamination, and earth hazards.

What should the Survey be doing in working toward economic development and environmental health in the best interests of the state using our particular scientific expertise? We have found discussions with both industry and government representatives particularly helpful. We were especially pleased to have the opportunity to review our activities with members of the Governor's staff, Mark Huddle and Jeff Miller, who visited the Survey in December, and with Senator Stanley Weaver and Representative Helen Satterthwaite, who reviewed our program in February. We are hopeful that others from government, industry, private business, and the public may visit or meet with us in the near future to further review our mission and discuss how we are meeting and how we may best meet the state's needs through our geological research and service efforts.

Improved communication and an enhanced Survey image should benefit the state and its citizens in the years to come. Our continuing goal is to provide sound and meaningful scientific information on the state's natural resources to both the private and public sectors and to government agencies to promote wise economic development in the state and ensure the quality of life of its citizens.

HONORS AND AWARDS

Robert A. Bauer received the Master of Science degree in geology from the University of Illinois at Urbana-Champaign. His specialty is rock mechanics.

Charles Collinson has been nominated to receive Honorary Membership in SEPM.

William Dale Farris received the Service Award, presented "In Honor and with deep appreciation of the faithful, devoted and valuable service given to the Midwest Water Well Exposition, 1954-1984.

Michael L. Sargent received an Award of Appreciation for Service to Parkland College for presenting a talk to a class at the college.

Howard R. Schwalb and Sandra Stecyk received the A. I. Levorsen Award for the best paper presentation at the annual meeting of the Eastern Section of the American Association of Petroleum Geologists at Carbondale, IL. His presentation, "Early geologic history of the Upper Mississippi embayment," also won the best poster award. The A. I. Levorsen Award emphasizes creative thinking toward new ideas in exploration.

Janis D. Treworgy received the Master of Science degree in geology from the University of Illinois at Urbana-Champaign. Her specialty is stratigraphy and depositional environments.

PAPERS AND ABSTRACTS IN NON-SURVEY PUBLICATIONS

Ainsworth, C. C., R. A. Griffin, I. G. Krapac, and W. R. Roy. 1984. Use of batch adsorption procedures for designing earthen liners for landfills. Proceedings of the Tenth Annual Research Symposium of the Solid and Hazardous Waste Research Division, U.S. Environmental Protection Agency, Cincinnati, OH 45268, Ft. Mitchell, Kentucky; April 3-5, 1984.

Barrows, M. H. (with R. M. Cluff, former staff member ISGS). New Albany Shale Group (Devonian-Mississippian) source rocks and hydrocarbon generation. AAPG Memoir 35.

Berg, R. C. 1984. Origin and early genesis of clay bands in youthful sandy soils along Lake Michigan, USA. Geoderma, no. 32, 45-62.

Bhagwat, S. B. Economics of the coal industry east of the Mississippi. Presented at AAPG - Eastern Section, Carbondale, IL, October 3, 1983.

Blodgett, K. D., R. E. Sparks, A. A. Paparo, R. A. Cahill, and R. V. Anderson. In press. Distribution of toxicity in the sediments of the Illinois waterway. Proceedings on Urban Effects on Water Quality and Quantity, 15 p.

Bradbury, J. C. In press. "Abrasives, Introduction" and "Siliceous Abrasives." Encyclopedia of Materials Science and Engineering, Pergamon Press, Oxford, England.

Cahill, R. A. and N. F. Shimp. In press. Inorganic contaminants in Lake Michigan sediments. In Toxic Contaminants in the Great Lakes. John Wiley and Sons, New York, NY.

Cahill, R. A. and J. C Mills. 1983. New data for trace element concentrations in Australian bituminous coals. Proceedings Australasian Institute of Mining and Metallurgy, no. 285, 39-43.

Cahill, R. A. and A. L. Delvalle. 1983. Application of lead-210 and cesium-137 in dating recent sediment of backwater areas associated with the Illinois and Mississippi Rivers. Proceedings National American Chemical Society Meeting, Nuclear Division, Washington, DC. (Abstract).

Cartwright, K., C. S. Hunt, R.D. Brower, and W. J. Nelson. 1983. Porewater pressure in the roof of an underground coal mine in Illinois, Ground Water 21:311-316.

Chou, C.-L. Siderophile trace elements in the earth's oceanic crust and upper mantle. Jour. of Geophysical Research, v. 88, p. A517-A518.

Chou, C.-L. Composition and distribution of mineral matter in the Herrin Coal of the Illinois Basin. Proceedings of the 1983 International Conference on Coal Science, p. 373-376.

Chou, C.-L., R. A. Cahill, J. D. Steele, L. R. Henderson, and R. S. Vogel. 1983. Geochemistry of trace elements and sulfur in the Springfield (No. 5) Coal in the Illinois Basin. Abstracts with Programs, v. 15, no. 6, p. 543. Annual Meeting of the Geological Society of America, Indianapolis, IN.

Chou, C.-L., and R. A. Peppers et al. Origin and economic geology of the Springfield Coal Member in the Illinois Basin. Guide Book for the Coal Division Field Trip at the GSA Annual Meeting.

Chou, C.-L. Inorganic Geochemistry of Illinois Basin Coal. Presented at the Eastern Section, AAPG, Carbondale, IL.

Chou, Mei-In, D. R. Dickerson, D. R. McKay, and J. S. Frye. 1983. Characterization of coal chars from a flash pyrolysis process by cross polarization/magic angle spinning ^{13}C NMR. Preprints of Direct Liquefaction of Coal, Chemistry, and Characterization Symposium, Div. of Fuel Chemistry, American Chemical Society 186th National Meeting, v. 28, no. 5, p. 130-136.

Chou, S.F.J. and R. A. Griffin. 1983. Solubility and soil mobility of polychlorinated biphenyls. In "PCBs and the Environment", Ed. J. S. Waid. CRC Press, Inc., Boca Raton, FL. 40 pp. (In press).

Coleman, D. D. 1984. Geochemistry of microbial methane. American Association of Petroleum Geologists Research Conference on the Geochemistry of Natural Gas, San Antonio, TX, February 12-15, 1984.

Coleman, D. D. 1984. Applications of isotope geochemistry to the distribution and storage of natural gas. Chevron Oil Field Research Company Workshop, La Habra, CA, February 16, 1984.

Coleman, D. D., C. L. Liu, and K. C. Hackley. 1983. Applications of sulfur isotope analysis to coal desulfurization. Illinois Coal Research Board Technical Conference, Champaign, no. 15-16, 1983.

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Kolata, D. R. 1983. Correlation of K-bentonites in the Decorah Subgroup of the Mississippi Valley by chemical fingerprinting. Guidebook for the 13th Annual Field Conference, Great Lakes Section, SEPM, Dubuque, IA, Sept. 30-Oct. 2, 1983.

Kolata, D. R., W. D. Huff, and J. K. Frost. 1983. Correlation of K-bentonites in the Decorah Subgroup of the Mississippi Valley by chemical fingerprinting: In D. J. Delgado, ed., Ordovician Galena Group of the Upper Mississippi Valley--Deposition, Diagenesis, and Paleoecology, Guidebook for the 13th Annul Field Conference of the Great Lakes Section, Society of Economic Paleontologists and Mineralogists, p. F1-F15.

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Mikulic, D. G. 1983. Hydrodynamic control of localized trilobite and cephalopod accumulations in Silurian carbonate buildups. Geological Soceity of America. Abstracts with Programs, v. 15, no. 6, p. 644. Annual Meeting, Indianapolis, IN.

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Schwalb, H. R. Early geologic history of the Upper Mississippi Embayment. Presented at Eastern Section, AAPG, Carbondale, IL.

Shiley, R. H., K. L. Konopka, R. A. Cahill, C. C. Hinckley, G. V. Smith, H. Twardowska, and M. Saporoschenko. 1983. Methods for detecting the mobility of trace elements during medium-temperature pyrolysis. Fuel, v. 62, p. 905-907.

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Stephenson, M. D. 1983. Sulfur species leached from pyrite during oxydative desulfurization of coal in alkaline solutions. Proceedings of the 1983 International Energy Conference, Pittsburgh, PA. International Energy Agency. p. 252-255.

Treworgy, J. D. A new feature in the Pennsylvanian of the Illinois Basin--Clastic infilling of a lacustrine basin. Abstracts with Programs, v. 15, no. 6, p. 708. Annual Meeting of the Geological Society of America, Indianapolis, IN.

SCIENTIFIC AND EDUCATIONAL CONTRIBUTIONS

Professional Societies

Calvin C. Ainsworth is a member of the ASTM D34 committee, section .02.05. That section is rewriting and editing a proposed procedure in the area of predictive methods and field verification. D34 is the Committee on Waste.

Joan K. Bartz was program chair of the "Women in Agronomy" standing committee of the American Society of Agronomy.

Robert A. Bauer is chairman of the Rock Mechanics committee, North-Central Section, Association of Engineering Geologists.

James W. Baxter is Corresponding Member of the Subcommission on Carboniferous Stratigraphy of the International Union of Geological Sciences, and Co-Chair, American Mississippian Stratigraphy Research Group, Society of Economic Paleontologists and Mineralogists.

Subhash Bhagwat was a member of the Planning Committee, 11th Energy Conference of DENR held November 1983.

James C. Bradbury serves on the following committees for the Society of Mining Engineers of the American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME): Vice-Chair, Technical Papers Subcommittee; Board of Editors, Industrial Minerals and Rocks, 4th and 5th Editions; member, Educational Issues Committee; member, Publications Board; and member, Mining Engineering Committee.

Ross D. Brower was a member of a proposal review committee for the University of Illinois Research Board.

Keros Cartwright is a member of the Committee of Hydrogeology, Geological Society of America Decade of North American Geology; Associate Editor, Geological Society of America Bulletin (term ended 12/31/83); Vice Chair, ASTM Sub-committee D18.14 on Waste Disposal on Land; member, ASTM Committee D34 on Waste; and Associate Editor, Journal of Groundwater (Elsevier Scientific Publishing Company).

Charles Collinson is a member of the Presidential Advisory Committee of the Society of Economic Paleontologists and Mineralogists; editorial reviewer, Illinois Academy of Science; and editorial reviewer, Paleontological Society.

Donald R. Dickerson is Co-Chair of the Science Talent Search Committee of the Illinois Academy of Science; and Survey representative and member of the Nominating Committee, University of Illinois Chapter, Society of the Sigma Xi.

William G. Dixon, Jr. chairs the North Central Section of the Association of Engineering Geologists (term ended 9/1983); and Editor, North-Central Section, Association of Engineering Geologists.

Robert H. Gilkeson is review editor for "Groundwater Monitoring Review"; and member, Program Committee for 2nd National Conference on Surface and Borehole Geophysical Methods in Groundwater Investigations.

Jonathan H. Goodwin was elected Secretary of the Yellowstone-Bighorn Research Association for the 8th straight year.

Robert A. Griffin was a member of the Conference Organizing Committee for the 6th Annual Madison Conference of Applied Research and Practice on Municipal and Industrial Waste (Sept. 1983); member, Science Advisory Committee US-EPA National Center for Ground Water Research, Tulsa, OK; member, US-EPA peer review panel and program review, Las Vegas, NV, (June 1983); and member, US-EPA peer review panel and program review, Daytona, FL, (Dec. 1983).

David L. Gross is newsletter editor for the Illinois-Indiana Section of the American Institute of Professional Geologists; and member, International Quaternary Association, Commission on Genesis and Lithology of Quatenary Deposits.

Ardith K. Hansel is a member of the Genetic Classification of Till and Criteria for Their Differnetiation Work Group, International Quaternary Association Commission on the Genesis and Lithology of Quaternary Deposits.

Richard D. Harvey serves as Secretary of the ASTM Subcommittee on Classification of Coal; and Acting Secretary, Illinois Mining Institute (during the leave of absence of Heinz Damberger).

Dennis R. Kolata represented the ISGS at the advance meeting of regional organizations for the 1989 GSA annual meeting to be held in St. Louis; and reviews articles for the Journal of Paleontology.

John M. Masters is a member of the Book Publishing Committee, Society of Mining Engineers, AIME.

Donald G. Mikulic critically reviewed manuscripts for the Iowa Geological Survey.

Rodney D. Norby has been named Program Chairman and Convenor for the 1984-85 meeting of the Pander Society to be held at De Kalb in 1985; the Survey's representative to the Pander Society for 10 years; and reviews articles for the Paleontological Society.

Vickie L. Poole was in charge of the Speaker Preparation/Slide Preview Room at the national GSA meeting at Indianapolis, Oct. 30-Nov. 3, 1983.

Philip C. Reed was Co-Chair of the Midwest Groundwater Conference.

Michael L. Sargent has provided editorial reviews of manuscripts in the Bulletin 60 series of the Illinois State Water Survey.

Beverly Seyler is Secretary-Treasurer of the Illinois Geological Society; she also served as official delegate from the Society to the Annual Meeting of the American Association of Petroleum Geologists, San Antonio, TX.

Neil F. Shimp is Vice Chairman of the ASTM D5 committee on Coal and Coke; Secretariat Chairman of Working Group 14 on Trace Elements in Coal, and member of Technical Committee 27 on Solid Mineral Fuels, International Standards Organization.

C. Brian Trask was Co-Chair of the Energy Minerals Division Symposium at the Eastern Section of AAPG meeting in Carbondale; and editor of a special publication of Coal Geology compiled from symposia papers sponsored by the Energy Minerals Division of Eastern Section of AAPG.

Lindell H. Van Dyke is on the memberhsip committee of the American Association of Petroleum Geologists.

Raymond S. Vogel is a member of the manuscript review boards for "Analytical Chemistry" and "Environmental Science and Technology" for the American Chemical Society.

Conferences and Field Trips

James W. Baxter participated in the affairs of the Subcommission on Carboniferous Stratigraphy at the Xth International Congress of Carboniferous Stratigraphy and Geology, Madrid, Spain, Sept. 1983.

James C. Bradbury and James W. Baxter escorted two deputy directors of the Pakistan Geological Survey (United Nations Fellows) on a field tour of the Illinois Fluorspar Mining District.

Richard A. Cahill presented the invited paper, "Application of lead-210 and cesium-137 in dating recent sediment of backwater areas associated with the Illinois and Mississippi Rivers," for the Nuclear Division at the 186th National Meeting of the American Chemical Society, Washington, DC, August 1983; and chaired a technical session at the Midwest Water Chemistry Workshop, October 1983.

Keros Cartwright was keynote speaker at the 6th Madison Conference for Applied Research and Practice on Municipal and Industrial Waste, Madison, WI, Sept. 1983.

Chen-Lin Chou served as co-leader for the Coal Geology Divison field trip for the Geological Society of America Annual Meeting, Indianapolis, IN, Oct. 30-Nov. 3, 1983.

Mei-In (Melissa) Chou presented the paper, "Characterization of coal chars from a flash pyrolysis process by cross polarization/magic angle spinning ^{13}C NMR," at the 186th Annual Meeting of the American Chemical Society, Washington, DC, Aug. 1983; and presented papers at the Illinois Coal Research Board Contractors' Technical Meetings in April and November 1983.

Dennis D. Coleman presented the paper, "Applications of sulfur isotope analysis to coal desulfurization," to the Board of Natural Resources and Conservation and to the Illinois Coal Research Board Contractors' Technical Meeting; and presented the paper, "Geochemistry of microbial methane," at an AAPG research conference on the Geochemistry of Natural Gas at San Antonio, TX, Feb. 1984.

Robert H. Gilkeson presented the paper, "Sulfur isotope study in Cambrian and Ordovician aquifers," at the 28th Annual Midwest Groundwater Conference, October 26-28, 1983; prepared Chapter VI, Application of Geophysical Techniques, for the Notebook of the Groundwater Monitoring Workshop, Champaign, IL, Feb. 27-28, 1984; presented the paper, "Definition of contaminant pathways: an integrated geophysical and geological study," at the 1st National Conference on Surface and Borehole Geophysical Methods in Groundwater Investigations, cosponsored by US-EPA and National Water Well Association, San Antonio, TX, Feb. 6-9, 1984; chaired two technical sessions at the 1st National Conference on Surface and Borehole Geophysical Methods in Groundwater Investigations, and is a member of the Program Committee for the 2nd National Conference scheduled for 1985; and is a review editor for "Groundwater Monitoring Review."

Robert A. Griffin presented invited papers at the following conferences: Subsurface Monitoring Technology Program, Denver, CO, May 1983; Working Together to Manage Wastes, Chicago, IL, June 1983; Natural Leachate Attenuation Mechanisms, Philadelphia, PA, Nov. 1983; American Association for the Advancement of Science, National Meeting, Detroit, MI, May 1983; and presented the paper, "Investigation of clay soil behavior and migration of industrial chemicals at Wilsonville, IL," to the 9th Annual Research Symposium of the Solid and Hazardous Waste Research Division, US-EPA, Cincinnati, OH, May 1983.

Ardith K. Hansel led field trips to the type Wedron Formation for University of Wisconsin and University of Stockholm geologists in August 1983; and with Leon Follmer for Professor Walter Vortisch, Phillips University, Marburg/Lahn, Germany, Nov. 1983; participated in a field project studying glacial features in SE Canada, NE Maine, and New Hampshire. The trip was led by geologists from the Geological Survey of Canada, University of Maine-Orono, and Ohio State University; led a field trip to the Chicago lake shore for University of Wisconsin faculty; and presented the paper, "Evidence for stagnant ice in the Chain o'Lakes lowland during deposition of Haeger and Wadsworth Till," at the North Central Section meeting of the Geological Society of America, Madison, WI, April 1983.

Beverly L. Herzog presented the paper, "A trench cover design to minimize radionuclide migration," at the annual meeting of the Illinois Academy of Sciences, Macomb, IL, April 1983; and presented the paper, "Laboratory and field studies of a layered cover to control infiltration of waste disposal sites," at the fall meeting of the American Geophysical Union, San Francisco, CA, December 1983.

Randall E. Hughes presented the paper, "Leakage of hazardous organic solutions through clay barriers in landfills," at the annual meeting of the Clay Minerals Society, Buffalo, NY, October 1983.

Dennis R. Kolata presented the paper, "Maquoketa Shale Group of northern Illinois," at the North Central Section meeting of the Geological Society of America, Madison, WI, April 1983; and presented the paper, "Correlation of K-bentonites in the Decorah Subgroup of the Mississippi valley by chemical fingerprinting," at the 13th Annual Field Conference, Great Lakes Section, SEPM, Dubuque, IA, Sept. 30-Oct. 2, 1983. He also organized and led portions of the field trip for this meeting.

Ivan G. Krapac presented the paper, "Variability of constituent concentrations in laboratory extracts from coal cleaning refuse," at the 6th Madison Conference of Applied Research and Practice on Municipal and Industrial Waste, Madison, WI, Sept. 1983.

Carl Kruse chaired a technical session at the Acid Rain Conference, Chicago, IL; and presented the poster paper, "Low-temperature carbonization of Illinois coals," at the Gordon Research Conference on Fuel Sciences at New Hampton, NH, July 1983.

Chao-Li (Jack) Liu presented the paper, "Application of natural sulfur isotope variations to the desulfurization of Illinois coal," to the Illinois Coal Research Board Contractors' Technical Meeting, Champaign, IL, Nov. 1983.

Donald G. Mikulic presented the paper, "Calcareous and hematitic oolites at the Ordovician-Silurian boundary of the central United States," at the North-Central Section meeting of the Geological Society of America, Madison, WI, April 1983; also led portions of a field trip and chaired a technical session at the meeting; and presented the paper, "Hydrodynamic control of localized trilobite and cephalopod accumulations in Silurian carbonate buildups," at the Annual meeting of the Geological Society of America, Indianapolis, IN, Oct. 30-Nov. 3, 1983.

Russell A. Peppers was a co-leader for the Coal Geology Division field trip for the annual meeting of the Geological Society of America. Indianapolis, IN, Oct. 30-Nov. 3, 1983.

Philip C. Reed was Co-Chair of the Midwest Groundwater Conference. He also chaired one technical session at the meeting.

J. Bruno Risatti presented the paper, "Acetate and the origin of sedimentary biogenic methane," at the meeting of the Geochemical Society, Indianapolis, IN, Oct. 30-Nov. 3, 1983. Dr. Risatti also chaired one of the technical sessions.

Massoud Rostam-Abadi presented the paper, "TGA studies of Illinois coal: effects of sulfur," at the 12th North America Thermal Analysis Society Conference, Williamsburg, VA, Sept. 25-29, 1983.

Michael L. Sargent represented the Survey at the Tri-State Geologic Field Conference at Black River Falls, WI, October 1983.

Michael D. Stephenson presented the paper, "Sulfur species leached from pyrite during oxydative desulfurization of coal in alkaline solutions," at the 1983 International Conference on Coal Science, Pittsburgh, PA, August 1983.

Raymond S. Vogel presented the invited paper, "Simultaneous, multi-integration periods in optical emission spectroscopy using photographic receivers," at the LABCON conference, Chicago, IL, September 1983.

Teaching, Lectures, and Seminars

Keros Cartwright presented a seminar for the Department of Geology, Northern Illinois University; and presented a lecture for a Short Course on Waste Disposal for the Department of Civil Engineering, University of Texas, Austin, TX.

Dennis D. Coleman presented 5 lectures at the University of Illinois-Urbana-Champaign and other Illinois colleges.

Heinz H. Damberger spent the 1983 academic year as a visiting professor at Ruhr University, Bochum, West Germany. He helped to establish a coal geology program at the university.

David L. Gross presented seminars at Allerton House for a conference on modeling of erosion and sedimentation processes in Illinois; at the INHS Grafton field station to the LTER/NSF oversight committee; at Urbana High School, and at Environmental Systems Research Institute, Redlands, CA. ESRI is the contractor for the Geographic Information System of the LUMP program.

Richard D. Harvey presented a lecture on coal petrology at Indiana University, Bloomington, IN; and presented a lecture on coal petrology for the Illinois-Indiana Section of the American Institute of Professional Geologists, Champaign, IL.

Beverly L. Herzog presented a lecture on, "Hydrogeologic investigations of the Wilsonville hazardous waste disposal site," to the Hydrosystems seminar of the Department of Civil Engineering, University of Illinois-Urbana-Champaign.

W. John Nelson and Donald K. Lumm presented a lecture on, "Structural geology of southeastern Illinois," to the Illinois-Indiana Section of the American Institute of Professional Geologists, Champaign, IL.

Rodney D. Norby presented a lecture to the Advanced Environmental Geology class, Department of Geology, University of Illinois-Urbana-Champaign.

Russel A. Peppers presented a lecture on palynology to a class in coal geology at Indiana University, Bloomington, IN; and provided advice for graduate students from the University of Illinois-Urbana-Champaign, Kent State University and Ball State University in studies on palynology. He also advised a graduate student from Michigan State University on Pennsylvanian stratigraphy.

Vickie L. Poole presented a lecture on, "Exploration and development of Saline Valley Conservancy District regional water supply," to a class in Groundwater Geology at Purdue University, West Lafayette, IN.

David L. Reinertsen presented an illustrated lecture on, "General geology of the Sangamon River Valley," to an environmental geology class at Sangamon State University, Springfield, IL; and showed a movie about the Survey's Lake Michigan research, with David Gross's taped narrative, and answered questions for the Earth Science club of Northern Illinois, Elmhurst, IL.

Beverly Seyler provided advice for 4 masters candidates from the University of Cincinnati; 4 from Southern Illinois University-Carbondale; 4 from University of Illinois-Urbana-Champaign, and 1 from University of Kentucky; and also provided selected drill core samples for a class in carbonate petrology at Northern Illinois University, Dekalb, IL.

Poster Sessions and Educational Exhibits

Chen-Lin Chou presented the paper, "Geochemistry of trace elements and sulfur in the Springfield (No. 5) coal in the Illinois Basin," in a poster session at the Geological Society of America Annual Meeting, Indianapolis, IN, Oct. 30-Nov. 3, 1983. (Co-authors Cahill, Steele, Henderson, and Vogel).

Phillip J. DeMaris presented the paper, "Coal-ball formation in the Herrin Coal, Franklin County, Illinois," in a poster session at the Geological Society of America Annual Meeting, Indianapolis, IN, Oct. 30-Nov. 3, 1983.

Philip C. Reed presented a poster exhibit with Ross Brower at the Illinois Irrigation Association meeting; and presented a poster exhibit with Ross Brower and Kemal Piskin at the meeting of the Illinois Water Well Association.

David L. Reinertsen set up and manned a lighted exhibit presenting information on engineering geology and on educational materials available from the Survey and the Department of Energy and Natural Resources for the Illinois Science Teacher's Association meeting in Normal, IL, Oct. 14-15, 1983; and set up and manned the Survey's display at the Annual Oil Men's Outing for the Illinois Oil and Gas Association, Rend Lake, IL, June 1983.

Workshops/Training

Richard A. Cahill chaired a technical session at the Midwest Water Chemistry Workshop in October 1983.

Dennis D. Coleman presented the paper, "Applications of isotopic geochemistry to the distribution and storage of natural gas," to a Chevron Oil Field Research Company workshop, La Habra, CA, Feb. 1984.

Robert A. Griffin presented invited papers at the following workshops: Workshop on Sanitary Landfill Design, Madison, WI, Feb. 1984, and Groundwater Monitoring Workshop, Champaign, IL, Feb. 1984.

Beverly Herzog taught a workshop on "Special techniques in construction of monitoring wells" at the Groundwater Monitoring Workshop sponsored by the ISGS and ISWS at Champaign, IL, Feb. 27-28, 1984.

Public Addresses

Morris W. Leighton presented the address, "The Illinois Geological Survey--Working towards economic development and a healthy environment," to the Illinois State Water Survey, Illinois Department of Energy and Natural Resources and the State Museum Division, Rockford Rotary Club, Geology Seminar of Northern Illinois University, Geography Seminar of University of Illinois, Illinois-Indiana Section of the American Institute of Professional Geologists, and North-Central Section of the Association of Engineering Geologists. He also presented the paper, "Keys to recent significant hydrocarbon discoveries in Latin America" to a Department of Geology seminar at the University of Illinois in October 1983.

Howard R. Schwalb presented an address entitled, "Early structural and depositional history of southern Illinois," at the annual meeting of the Illinois Oil and Gas Association.

Beverly Seyler presented the address, "Environments of deposition, diagenesis and exploration models of Aux Vases Sandstone," to the Illinois Geological Society.

Radio, TV, Press Interviews/Presentations

Ross D. Brower held interviews on environmental issues with reporters from the Daily Illini, the University of Illinois Office of Public Affairs, and the Chicago Sun Times.

Paul C. Heigold provided 3 taped interviews on Illinois seismicity for radio stations in Beleville, Peoria, and the Quad Cities area.

Morris W. Leighton spoke at half-time of the Illinois-Indiana basketball game on WDWS "Illini Minutes," briefly describing the Geological Survey.

Vickie L. Poole was interviewed for the Evansville (IN) Sunday Courier and Press on quality of water supply from the Saline Valley Conservancy District.

Howard R. Schwalb discussed the oil producing potential of the greater Decatur area in an interview on WAND-TV (Channel 17) 6:00 p.m. news program.

William L. Wells was interviewed for a feature story on new funding for the Center for Research on Sulfur in Coal by WAND-TV (Channel 17). The story aired on the 6:00 p.m. news program.

Governmental Committees

Ross D. Brower is a member of the technical review committee for proposals on deep well injection waste disposal submitted to the IL EPA.

Keros Cartwright is a member of the Science Advisory Board, Committee on Long-Term Research Planning, US EPA; member, Special Committee on Hazardous Waste Siting Guidance, US EPA; member, Review Committee on the Basalt Waste Isolation Project (High Level Radiooactive Waste), US DOE/ Rockwell International; member, Committee on Low-Level Waste, Illinois Commission on Atomic Energy; member, Committee on Land Disposal, Illinois Hazardous Waste Task Force; member, Task Force on Underground Water, Illinois State Water Plan; member, Peer Review Committee for Earth Science Division, Lawrence Berkeley Laboratory, University of California at Berkeley; represented the ISGS at the US EPA/National Water Well Association Special Conference on Groundwater Classification; represented the ISGS at the US EPA Special Conference on Hydraulic Conductivity of Fine-Grained Sediments; and represented the ISGS at the US EPA Special Conference on Monitoring Hazardous Waste Disposal Sites in Wetlands and Saturated Sediments.

Charles Collinson is a member of the Technical Advisory Committee on Research and Development, US Great Lakes Commission, Ann Arbor, MI; named Vice-Chair of the Committee in March, 1984; and Illinois Coordinator for Hazardous Spills in Lake Michigan.

Robert A. Griffin was named to the newly formed national institute at the University of Alabama Environmental Institute for Waste Management Studies. The purpose of the institute is to study the technical, social and economic issues related to safe management of the nation's wastes and to make the findings available to Congress, state legislatures, governmental agencies, and the public.

David L. Gross is a member of the LUMP oversight committee; and member of the LTER Executive Committee.

Morris W. Leighton serves as Chairman of the Institutional Advisory Board for the Center for Research on Sulfur in Coal (CRSC); serves on the Board of Directors for the Illinois Mining and Mineral Resources Research Institute (IMMRRI), Southern Illinois University at Carbondale; and is secretary of the Coal Advisory Committee, industrial representatives brought together to exchange ideas with the Survey.

David L. Reinertsen represents the Director on the Statewide Advisory Board for Conservation Education of the State Board of Education; represented the Survey on the Statewide Advisory Committee of the Community Information and Education Service, a cooperative project of the University of Illinois and the W. K. Kellogg Foundation; and presented a talk about the Survey's Educational Extension program to the State Advisory Board at Springfield on October 18, 1983.

William L. Wells is Director of the Center for Research on Sulfur in Coal, a member of its Industrial Advisory Board and its Institutional Advisory Board; he also serves on the IAB's Technical Committee.

Governmental Testimony/Presentations

Vickie L. Poole held phone conversations, wrote letters and sent report excerpts to the Greater Egypt Regional Planning Commission regarding contamination of water supplies connected with injection wells and abandoned wells; and supplied letters, maps, and advice and counsel to the Illinois Department of Mines and Minerals regarding applications for surface disposal of mine wastes near the Saline Valley Conservancy District's well field.

Philip C. Reed presented a talk on hydrogeology for the mayor and town and state officials at Enfield, IL; presented a talk on hydrogeology for the mayor and town officials at Benld, IL; and prepared materials for count testimony on Theory of Electrical Earth Resistivity and on Oil Field Brine Contamination.

David L. Reinertsen represented the Survey at a field trip in the LaRue-Pine Hills area, Shawnee National Forest, sponsored by the US Forest Service, Federal Highway Administration and IL Department of Transportation to consider resurfacing and widening of roads in the area.

Michael L. Sargent is a member of the ISWS Committee on Aquifer Systems. This committee is an advisory panel for the North American Commission on Stratigraphic Nomenclature.

Howard R. Schwalb assisted the Illinois Department of Agriculture in preparation of toxic waste labels for oil field bactericides.

Service on Industrial Committees

Ross D. Brower is a member of the Technical Review Committee on Compressed Air Energy Storage Research, sponsored by the Electric Power Research Institute; member of the Review Committee for ISWS Bulletin 60 Series; and historian for the Midwest Groundwater Conference.

Richard H. Howard is member of the Enhanced Recovery Committee of the Interstate Oil Compact Commission; member, Area C Subcommittee, National Potential Gas Committee; and member, Geological Committee, Illinois Oil and Gas Association.

Russell J. Jacobson chairs the Tri-State Committee on Correlations in the Pennsylvanian System of the Illinois Basin. C. Brian Trask is Secretary of the Commission.

Howard R. Schwalb is a member of the Energy Resources Committee, Interstate Oil Compact Commission.

Beverly Seyler presented a lecture on, "Exploration models for Aux Vases Sandstone," for Marathon Oil Co. Geologists at Mt. Vernon, IL.

Jacob Van Den Berg is Chairman, District 5, for the Committee on Statistics of Drilling of the American Association of Petroleum Geologists; and respondent for Illinois oil well completion data for the American Petroleum Institute.2

Public Service

David L. Gross is a member of the Board of Directors and the Executive Committee of United Way of Champaign County; and Chairman of the Board, Voluntary Action Center of Champaign County.

John M. Masters is Judging Chairman for the Earth Science Division of the Illinois Junior Academy of Science. Philip C. Reed is co-chairman.

GEOLOGICAL SURVEY ACTIVITY MEASURES

Background

All Illinois state agencies are required to provide activity measures when submitting their next fiscal year's budget. The Governor's "Illinois State Budget" book also requires selected activity measures. Activity measures are helpful internal indicators of how we are doing, where our energies are going, and to what degree we may need to adjust or re-shape our program, budget, and organization. Activity measures help to indicate how the public, private, and governmental sections may gauge our effectiveness.

While records are kept throughout the year on such items as publications and presentations, many of our activity measures are based on results accumulated over specific sampling periods and then adjusted to an annual rate. We believe this type of limited survey provides the level of accuracy needed for this type of information. The more notable contributions of Survey personnel are to be found under the heading "Recognition and Service" in this report.

Measures

Research Activities. The number of 100-percent state-funded projects was 155 with approximately an even balance between Mineral Resources, Environmental Geology, and General and Basic Research. The figure includes both major and minor projects. Sponsored research projects total 70, about a third of the total number of research projects at the Survey. In our research efforts we compiled 198 written reports and maps and distributed 14,528 publications and 22,682 maps.

Public, Government, and Business Service Activities. Table 4 gives a summary of selected activity measures for this segment of our business.

- Information Responses: We responded to inquiries from 8,170 visitors, 10,701 phone calls, and 5,017 letters. The Geological Records Unit had a record year handling 125,173 files and the Samples Library made 989 sets of samples available for examination and study.

- Identification Analyses/Report Memos: More than 6,500 samples were analyzed leading to 294 separate memo reports. Also, 316 memos and letters addressed other matters mainly on mineral resources. In addition the Survey issued 580 groundwater reports, 42 waste disposal reports, 50 deep-well dispositional reports, 10 ground stability reports and 104 mine subsidence reports. An additional 257 letters and memos were written to address other matters. Chemical analyses were made of 2,631 samples, and included 28,888 separate determinations.

Continuing Scientific/Education Contributions: Survey personnel provided 131 outside papers on abstracts and actively participated in 122 conferences and field trips to further its educational and scientific goals. The Survey further supported higher education by contributing to 44 school seminars and lectures, 26 poster sessions and educational exhibits, and 39 workshops or training courses for a total of 109 as shown in Table 4. In addition, Survey personnel served on 78 outside committees and held offices in 27 scientific or educational organizations. Survey staff also reviewed 7 outside manuscripts and provided counsel and guidance to 9 graduate students. In-house conferences numbered 284 to aid additional scientific and educational goals. The Survey also issued 130 rock and mineral sets to Illinois schools.

Public, Industry, Governmental Affairs: Survey staff made 29 public speeches, gave 30 talks or interviews to the media, participated in 21 governmental hearings or special meetings, and contributed 60 individual appearances before public, industry, and government conferences and committees. Total appearances for invited lectures, talks, and presentations (including those under Scientific/Educational Contributions) numbered 393 (see Table 4).

Table 4. Illinois State Geological Survey Selected Activity Measures 1983-84

Survey programs	Reports written (distributed)	Invited lectures talks and presentations	Workshops seminars and training sessions	Phone inquiries	Visitors and office conferences	Letter inquiries
Mineral Resources	50	83	10	5,337	4,627	800
Environmental Geology	70	187	62	1,247	343	246
General Research	78	116	33	942	595	371
Administrative and Support Services	(14,528)	7	4	3,175	2,605	3,600
Grand total	155(14,528)	393	109	10,701	8,170	5,017

ILLINOIS STATE GEOLOGICAL SURVEY
FULL-TIME AND PERMANENT PART-TIME STAFF

May 1, 1984 Champaign, Illinois

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Joint research by the State Geological Survey, Argonne National Laboratory, Northwestern University, Southern Illinois University, University of Illinois-Chicago, and University of Illinois-Urbana

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